THURSDAY, APRIL 4, 1878

THE SCOTTISH UNIVERSITIES COMMISSION

THE Report of the Royal Commissioners appointed to inquire into the Universities of Scotland, together with Evidence and Appendix, has just been issued. We will begin our reference to this important document with an extract (p. 49):—

"It would, we consider, be a misfortune if the separate individuality which has long characterised the Scottish Universities were impaired, and if the spontaneous and healthy development of different schools of thought were rendered impossible by laying an obligation on men of original genius to make their teaching subservient in all its details to the requirements of an extraneous examining authority. The admirable influence which the Scottish Universities have hitherto exerted upon the people of the country has been due not only to the prolonged and systematic course of mental discipline to which their students have been subjected, but to the stimulus and encouragement given to inquiring minds by distinguished men who have made the professorial chairs centres of intellectual life; and we cannot think it desirable that any such changes should be made as would tend to lower the Universities into mere preparatory schools for some central examining board."

These words are peculiarly noteworthy at the present time, when attempts at centralisation are becoming more rampant than ever:—and when the general tendency of so-called "Educational Reform" is to substitute for teaching in the highest sense, an almost Chinese system of examinations, with their inevitable attendant *Cram*. For the true definition of Cram is "preparation for examination, and for examination alone":—and its varieties are infinite, ranging as they do from processes closely resembling the manufacture of *foie gras* in the live bird, to those which are adopted in dressing diseased meat for the market. The Scottish Universities have, it seems, been hitherto singularly free from this monstrous evil; and, it is to be hoped, will remain so. The Commissioners who are now dealing with our great English Universities would do well to pay particular attention to this point, for Cram, in its worst forms, is by no means a stranger to them. The true cure for this evil is very well stated in the Report (p. 49):—

"The examination of the students of a University for their degrees by the Professors who have taught them is sometimes spoken of as an obvious mistake, if not abuse; but those who are practically acquainted with University work will probably agree with us that the converse proposition is nearer the truth. In fact, it is hard to conceive that an examination in any of the higher and more extensive departments of literature or science can be conducted with fairness to the student, unless the examiners are guided by that intimate acquaintance with the extent and the method of the teaching to which the learner has had access, which is possessed only by the teachers themselves."

Nothing could be more true, or more happily put. Let all University instruction (in England as well as in Scotland) be real *teaching*, such as is (or at least ought to be) given by Professors or Lecturers and their specially chosen Assistants, and let the teachers be in the main the examiners. Mere speed of writing, and other similar qualifications, are unworthy the notice of scientific men or scholars—and certainly ought to have no influence in a University Examination, at least until Universities are furnished with Professors of Caligraphy, Maintien, &c., attendance upon whose lectures shall be made compulsory. It is right and proper that such things should be looked to in Civil Service Examinations and the like—just as it is right that the candidates in some of these should be submitted to medical inspection. But who ever heard of medical inspection in a University examination?

But we now come to the one true difficulty in this part of the question:—*How to choose Professors.* On this point there are several very useful hints, both in the *Report* itself and in the *Evidence* appended.[1] The Commissioners do not seem very decided in their recommendations, so many widely differing and yet individually plausible schemes have been submitted to them. But practically the patronage seems from the evidence to be very fairly bestowed (*i.e.*, in very good hands) in the majority of the Scottish Universities. The main exception is that of Edinburgh, where several of the most important chairs were left by the Universities (Scotland) Act, 1858, virtually in the gift of the Town Council, which had been up to that date the supreme authority in the metropolitan University. Such a state of things is barely credible to us in England. For, though custom has familiarised us with great schools under the management of City Companies, we could hardly imagine the Mayor and Aldermen of Cambridge electing to the Lowndean or Lucasian Professorship. Yet the chairs once held by Maclaurin, Black, Leslie, Dugald Stewart, &c., are at the disposal of a Board of seven, four of whom are nominated by the Edinburgh Town Council! Instead of the heroic treatment which such malformation demands, and which would probably have made opposition impossible; the Commissioners propose merely to create two additional members of this Board, so as to place the Town Council representatives in a minority; a step whose timidity may only ensure a violent, and too probably a successful, resistance.

It appears clearly from these volumes that the one great want of the Scottish Universities is *money*. Over and over again, throughout the evidence, this is painfully brought out. Yet, with their few thousands these Universities are at present educating many more students than Oxford and Cambridge together, each of them with its annual hundreds of thousands. And the education given to each and all is generally of the highest order, because it is given by the Professors themselves. How many Cambridge men go for instruction to Cayley or Stokes—to Munro or Kennedy? Of names like these Cambridge is justly proud. But unfortunately such teaching as these men could give *doesn't pay*, so the "coach" is resorted to! In Scotland the Professors are the teachers, hourly accessible to all, and among the latest additions to their ranks we find the names of Jebb and Chrystal. They will do more good to students now in one year than they could have done in a lifetime spent in Cambridge! Comment on such a statement is needless.

After what we have just said, the reader will scarcely be

[1] The Analysis or Abstract of the Evidence, which is contained along with the Report itself in the first of these four Volumes, seems to be exceedingly well executed throughout. This is one of the specially good features of the work, and Prof. Berry, the Secretary to the Commission, deserves high credit for it.

prepared to hear that one great reproach to the Scottish University system is commonly thought to lie in the shortness of the session, as it is called. This is a great point with would-be University reformers—"Go to, ye are idle." But it will be found, on examination, that the compulsory working-time *per annum* is longer at the Scottish than at the English Universities:—whence men go down regularly whenever term divides. In Scotland the majority of the lectures continue uninterrupted (except by the week from Christmas to New Year) from the end of October to the middle of April; and by that time both students and professors *require* some relaxation, especially those who have to teach or attend the summer classes, which occupy the whole of the months of May, June, and July. The Commissioners have no hesitation on these points, and meet the grumblers very sharply. They say:—

"Without saying that the present arrangement of the academical year is the best that could be devised, it is that which long experience has shown to be the most suitable to the circumstances of Scotland. Nor is it without its advantages for the purposes of study. To the well-advanced and intelligent the vacation affords an opportunity for reflection and self-culture, so as to prevent his University education from degenerating into a mere acceptance of facts and conclusions from the mouth of his teacher. For a student, indeed, who is backward or indolent, the leisure afforded by the long vacation may be useless and hurtful. But to meet the case of such students the fitting remedy is that which we have already stated, the institution of summer tutorial classes where these do not now exist, and their extension, if necessary, where they do."

Our readers are already acquainted with the Report of the Devonshire Commission. A good deal of the evidence which that body collected has been taken as repeated before the present Commissioners, and they adopt, and strongly urge the carrying out of, several of the recommendations of their predecessors:—especially those which concern grants of public money for the extension of buildings and appliances for Science teaching in the Scottish Universities. It is well that this has been done, for attention has thus been recalled to one of the most important documents connected with education which has ever been laid before Parliament, and which (probably because of the moneys it recommended to be granted) has been practically shelved for some years.

So far we have been dealing with the Report as a whole. We must now more particularly examine it as regards *Science*. And this, we fancy, will be allowed to be its weakest point. The Commission was exceedingly strong on the literary, legal, and general-culture side:—but very weak—numerically at least—on the scientific. It is no disparagement to such men as Dr. Lyon Playfair and Prof. Huxley (who were the *two* representatives of Science among *twelve* Commissioners) to say that they cannot adequately represent *all* science. For there are three great divisions of Science, the Observational, the Experimental, and the Mathematical, and the third and greatest of these was altogether unrepresented on the Commission. This was a very grave defect, and the value of the Report is considerably reduced in consequence.

So strong, in fact overwhelming, was the general culture side—including Members (or ex-Members) of both Houses of Parliament, Scottish (and Indian) Judges and Advocates, &c.—that the Report cannot fail to surprise all readers by its general tenor. For there can be no question that in it Science has managed to carry the day against all comers:—the greater the pity that it was not fully represented, if but by the addition of a single mathematician. To make room for him, a lawyer might easily have been spared.

We cannot spare space for more than one instance of the proposed revolution:—but we choose an important and typical one, the modifications to be made in the mode of attaining the degree of M.A. This degree has hitherto, in Scotland, involved a certain amount of knowledge of *each* of the following seven subjects:—Latin, Greek, Mathematics, Logic, English Literature, and Moral and Natural Philosophy:—and has not been at all nearly so easy to attain as the ordinary (or Poll) degree in the English Universities—which, though at first styled only B.A., becomes M.A. by mere lapse of time and payment of additional fees, and is therefore practically the same thing. In Scotland it is now proposed that there shall be five distinct avenues (several with alternative branches) to this degree in addition to the present one:— (p. 25)

"Moved by these considerations, we have come to the conclusion that to secure a basis of general culture every student proposing to proceed to the degree of M.A. should be required to pass a 'First Examination' in Latin, Greek, Mathematics, English, and, when the state of education in the schools renders it practicable, in Elementary, Physical and Natural, Science. This examination should be passed at the beginning of the University session,—either the winter or the summer session,—every student proposing to graduate being required to pass it, whether he may have been previously a student in the University or not. With some modification, the examination might be so adapted as to apply not only to students proceeding to a degree in Arts, but to those also intending to graduate in Law, Science, or Medicine. In the case of persons proceeding in Law, we think that an examination in translating from French or German should be allowed as an option for Greek. Again, in the case of students proposing to graduate in Science or Medicine, we think that, as some knowledge of modern languages is most important to them, they should be examined either in translating from French and German, or in translating from one of the languages and in Greek. In this way, it would be necessary for them to show ability to translate from at least one modern language.

"As we shall explain afterwards, we regard this as the best equivalent for an entrance examination. Through its application to all proposing to graduate, whether previously students at the University or having come direct from school, a salutary reflex action on the schools will be secured by the encouragement given to them to send their pupils to the University in an advanced state of preparation. In a different shape, and if accompanied by the condition of exclusion from the University should the candidate fail to pass, an entrance examination would, in our opinion, be attended with injury rather than benefit.

"After passing the 'First Examination,' the candidate for a degree in Arts should be allowed to proceed in the present course, if he please, and as, no doubt, many will still do. If, however, he prefer to take a different course, we propose that he should be allowed to take any one of the five following departments or lines of study, viz.:—

"I. Literature and Philology.
II. Philosophy.
III. Law and History.
IV. Mathematical Science.
V. Natural Science.

"The branches to be included under these different departments we propose should be as follows:—

"I. Literature and Philology should comprise the subjects of Latin; Greek; and English Literature; together with one of the following subjects, viz.: Comparative Philology; Sanskrit; Hebrew; a Modern Language; Gaelic, with Celtic Philology. Questions on history and geography incidental to each subject should form part of the examination.

"II. Philosophy should include Logic and Metaphysics; Ethics and Psychology; and the Physiology of the Nervous System. The first two subjects are understood to embrace the History of Philosophy.

"III. Law and History should include Civil Law; either Constitutional Law or International Law; and Political Economy; together with the history of any one of the following groups, viz.: Greece and Rome; Modern Europe; Egypt, Syria, Palestine, and Arabia; India; Ancient and Modern America.

"IV. Mathematical Science should embrace Mathematics, pure and applied; Natural Philosophy; and Physical Astronomy.

"V. Natural Science should comprehend four groups, viz.:—(1) Applied Mathematics, Natural Philosophy, and Chemistry; (2) Natural Philosophy, Chemistry and Physiology; (3) Physiology, Botany, and Zoology; (4) Natural Philosophy, Chemistry, and Geology. A candidate should be allowed to take any two of these four groups; and the practical working of the arrangement would be that Natural Philosophy and Chemistry would be compulsory, while any option would be given between the mathematical and the morphological sciences.

"It may be explained that the subjects of examination in the sciences comprehended in Department V. are such as are required in the first Bachelor of Science examination as detailed in the Calendars of the Universities of Edinburgh and London (1877). The purpose we have had in subdividing the subjects of Department V. into groups has been, in the first place, to ensure a sound acquaintance with Physics and Chemistry, which lie at the foundation of all natural science; and, in the second place, so much being secured, to give fair play to individual intellectual tastes and peculiarities. It is rare to find a man equally capable of dealing with long chains of abstract reasoning, or with experimental research, and of observing and remembering the analogies and differences of form. The scientific aptitude, when strongly marked, is either for mathematics, for experimental investigation, or for morphology, rarely for all three.

"In regard to the scientific subjects, mere book knowledge should not suffice; practical work in the laboratory should be essential."

We are much mistaken if this Report does not produce great irritation, amounting in many quarters to white heat at least, and determined opposition. The dry husks of speculative "philosophy" which, feebly existent even in the present day (like Bunyan's *Pope* and *Pagan*), formed so large an ingredient in the mental pabulum of Scottish students in the past, are doomed to "cease from troubling":—but they will die hard. In their place will come the still oppressed truths of modern science, and the legitimate speculations which Experience and mathematical power alone can enable the human mind to originate and develop.

SUN-SPOTS AND RAINFALL

THE paper which we print from Mr. Meldrum this week, appearing as it does within a few days of the debate in the House of Commons on the Indian Famine expenditure, is one which should be interesting to many besides professed meteorologists. It will, for one thing, enable even the most unscientific among us to see the manner in which men of science are striving to arrive at the truths of nature the while the average Member of Parliament only refers to their labours in order to sneer at them even when their results may elucidate a question of high national importance.

Granting that the Member for Cambridge comes up to the average of our legislators, let us see how he distinguished himself on Tuesday. In his indictment of the policy of Sir John Strachey, he was unwise enough to touch on the question of the connection between sun-spots and the Indian rainfall. "It appeared that, according to the astronomer to the government at Madras, the absence of several important spots (*sic*) on the sun's disc was connected with the retarded rainfall." It is clear from this, we think, that Mr. Smollett, in his ignorance of all things solar, instead of taking a little trouble to inform himself, has built up a mental image of the physics of our central luminary, by likening it to the house of which we will grant again he is one of the most prominent units. The cause of the sun-spot minimum appears to him to be that at this time "several important spots"—let us say the Smolletts of the sun—are in the tea-room or at dinner, anyhow they are absent from the division, and the opposition carries the day—that is, if Mr. Pogson is right, but he proceeds to show that Mr. Pogson is wrong.

Dr. Lyon Playfair, as was to be expected, put this matter right before the house. He stated that "it was established that famines in India came at periods when sun-spots were not visible. Out of twenty-two great observatories of the world it had been shown in eighteen that the minimum rainfall was at times when there were no spots on the sun. That was as true in Edinburgh as in Madras, in St. Petersburg as in Australia. It was therefore essential for the Government of India to take that into consideration in calculating as to when famines were likely to occur. The Secretary of State for India had acted wisely in sending out photographers to the Himalayas to take photographs of the sun, and having seen some of those, he was sorry to say that on none which he had seen were spots to be detected." As Dr. Playfair is not in the habit of making statements without getting up his case, we may be thankful to Mr. Smollett for the sneer which called Dr. Playfair up.

Mr. Meldrum's communication contains a very condensed reference to his memoir on Sun-spots and Rainfall recently presented by him to the Meteorological Society of the Mauritius, a memoir which goes far to complete one portion of that magnificent edifice, the erection of which was foreseen by Sir Wm. Herschel at the beginning of the present century.

In this important paper Mr. Meldrum, than whom there exists no higher authority, states that the result of his seven years' work has been to convince him that the connection between sun-spots and rainfall is as intimate as that between sun-spots and terrestrial magnetism; and that having regard to the number of cycles at our disposal we should be as justified in rejecting the diurnal oscillation of the barometer as the curve along the hills and hollows of which the maximum and minimum rainfalls of the world lie.

This result of course will be received with incredulity

by many—and for many reasons. In the first place the enormous variation in the solar activity is a fact only fully realised by very few. Men grown old in the service of science are as a rule as little anxious to receive new ideas as men grown old in any other of the world's activities, and further and more than this, in the case of many there is what has recently been happily termed "a paralysis of the imagination"—a thing far removed from scientific caution—which may and indeed certainly would do much harm to scientific progress if those afflicted with it had any chance of having the exclusive say in the matter.

Now that things have arrived at this stage it is well to bring to the front some extracts from those papers of Sir Wm. Herschel's to which reference has already been made, to show the wonderful prescience of the man, and also to give an idea of the valuable time which has been lost by the neglect, during three-quarters of a century, to take in hand the work from which he predicted such a rich harvest of benefits would follow.

His first reference to the *changes* going on in the sun was made in 1801.[1] He writes :—

"On a former occasion I have shown that we have great reason to look upon the sun as a most magnificent habitable globe ; and, from the observations which will be related in this paper, it will now be seen that all arguments we have used before are not only confirmed, but that we are encouraged to go a considerable step further in the investigation of the physical and planetary construction of the sun. The influence of this eminent body on the globe we inhabit is so great and so widely diffused that it becomes almost a duty for us to study the operations which are carried on upon the solar surface. Since light and heat are so essential to our well-being, it must certainly be right of us to look into the source from whence they are derived, in order to see whether some material advantage may not be drawn from a thorough acquaintance with the causes from which they originate.

"A similar motive engaged the Egyptians formerly to study and watch the motions of the Nile and to construct instruments for measuring its rise with accuracy. They knew very well that it was not in their power to add one single inch to the flowing waters of that wonderful river ; and so, in the case of the sun's influence, we are likewise fully aware that we shall never be able to occasion the least alteration in the operations which are carried on in the solar atmosphere. But if the Egyptians could avail themselves of the indications of a good Nilometer, what should hinder us from drawing as profitable consequences from solar observations? We are not only in possession of photometers and thermometers, by which we can measure from time to time the light and heat actually received from the sun, but have more especially telescopes, that may lead us to a discovery of the causes which dispose the sun to emit more or less copiously the rays which occasion either of them ; and if we should even fail in this respect, we may at least succeed in becoming acquainted with certain symptoms or indications, from which some judgment might be formed of the temperature of the seasons we are likely to have.

"Perhaps our confidence in solar observations made with this view, might not exceed that which we now place on the indications of a good barometer with regard to rain or fair weather ; but even then a probability of a hot summer, or its contrary, would always be of greater consequence than the expectation of a few fair or rainy days.

[1] "Observations tending to investigate the Nature of the Sun in order to find the Causes or Symptoms of its Variable Emission of Light and Heat ; with Remarks on the Use that may possibly be drawn from Solar Observations." By William Herschel, LL.D., F.R.S., read April 16, 1801.

"It will be easily perceived that in order to obtain such an intimate knowledge of the sun as that which is required for the purpose here pointed out, a true information must be first procured of all the phenomena which usually appear on its surface."

He then gives those wonderful observations which make this paper the basis of our knowledge of the smaller units of the sun's surface, and then sums up as follows :—

"From these two last sets of observations, one of which establishes the scarcity of the luminous clouds, while the other shows their great abundance, *I think we may reasonably conclude that there must be a manifest difference in the emission of light and heat from the sun.* It appears to me, if I may be permitted the metaphor, that our sun has for some time past been labouring under an indisposition, from which it is now on a fair way of recovering.

"An application of the foregoing method, however, even if we were perfectly assured of its being well founded, will still remain attended with considerable difficulties. We see how, in that simple instrument the barometer, our expectations of rain and fair weather are only to be had by a consideration of many circumstances besides its actual elevation at the moment of inspection. The tides also present us with the most complicated varieties in their greatest elevation, as well as in the time when they happen on the coasts of different parts of the globe. The simplicity of their cause, the solar and lunar attractions we might have expected, would have precluded every extraordinary and seemingly discordant results.

"In a much higher degree may *the influence of more or less light from the sun be liable to produce a great variety in the severity or mildness of the seasons of different climates and under different local circumstances*, yet when many things which are already known to affect the temperature of different countries and others which future attention may still discover, come to be properly combined with the results we propose to draw from solar observations, we may possibly find this subject less intricate than we might apprehend on a first view of it.

"If for instance we should have a warm summer in this country when phenomena observed in the sun indicate the expectation of it, I should by no means consider it as an unsurmountable objection, if it were shown that in another country the weather had not been so favourable.

"And if it were generally found that our prognostication from solar observations held good in any one given place I should be ready to say that with proper modifications they would equally succeed in every other situation.

"Before we can generalise the influence of a certain cause we ought to confine our experiment to one permanent situation, where local circumstances may be supposed to act nearly alike at all times which will remove a number of difficulties."

This was in April ; in May he read another paper.[1]

"Having brought the solar observations relating to the symptoms of copious emission of the light and heat of the sun to the 2nd of March I gave them continued in this paper to the 3rd of May. It will be seen that my expectations of the continuance of the symptoms which I supposed favourable to such emissions, have hitherto been sufficiently verified ; and by comparing the phenomena I have reported with the corresponding mildness of the season, my arguments will receive a considerable support.

"I have given the following observations without delay as containing an outline of the method we ought to pursue in order to establish the principles which have been pointed out in my former paper. But we need not in future be at a

[1] "Additional Observations tending to Investigate the Symptoms of the Variable Emissions of the Light and Heat of the Sun ; with Trials to set aside darkening Glasses by Transmitting the Solar Rays through Liquids, and a few Remarks to Remove Objections that might be made against some of the Arguments contained in the former Paper," by William Herschel LL.D., F.R.S. Read May 14, 1801.

loss how to come at the truth of the current temperature of this climate as the thermometrical observations which are now regularly published in the *Philosophical Transactions* can furnish us with a proper standard with which the solar phenomena may be compared. This leads me to remark that although I have in my first paper sufficiently noticed the want of proper criterion for ascertaining the temperature of the early periods where the sun has been recorded to have been without spots, *and have also referred to future observations for showing whether a due distribution of dry and wet weather with other circumstances which are known to favour the vegetation of corn, do or do not require a certain regular emission of the solar beams*, yet I might still have added that the actual object we have in view is perfectly independent of the result of any observations that may hereafter be made on the *favourable or defective vegetation of grain in this or in any other climate* . . . . It may be hoped that some advantage may be derived even in agricultural economy, from an improved knowledge of the nature of the sun and of the causes or symptoms of its emitting light or heat more or less copiously."

It perhaps will be news to many that the idea of a possible connecttion between sun-spots and rainfall which has been represented as a modern idea, may really be credited to a man whose chief work was done in the last century.

DARWIN'S "DIFFERENT FORMS OF FLOWERS"

The Different Forms of Flowers on Plants of the same Species. By Charles Darwin, M.A., F.R.S. (London: John Murray, 1877.)

THIS is another of the remarkable series of volumes in which Mr. Darwin has given us the extremely valuable results of his researches in the vegetable side of biology. Mr. Darwin's method of investigation would in itself be a very interesting subject for consideration. It is, however, sufficient to point out that its characteristic feature is the combined attack upon a given problem from both its morphological and physiological aspects. This method Mr. Darwin employs with consummate success, and in turning over the pages of the present book—a considerable part of which has been before the world for more than a decade without being materially impugned—one is almost distracted from the intrinsic interest of the facts and speculations by the sagacity with which the research is carried on, and the skill with which the results are marshalled for our information. It is peculiarly worthy of notice in the present volume how the reader is allowed, in studying Mr. Darwin's pages, to form his own hypotheses in explanation of the facts, only to be compelled in due course, as the narrative proceeds, to admit that such hypotheses are utterly untenable. There is no impression so curious as to find oneself so distinctly under the hands of a master, and to realise that the calm flow of the argument proceeds over the *débris* of objections and difficulties which are found to be already comminuted as soon as one attempts to give them any definite form.

It would be quite impossible to treat, in the short space at our disposal, all that calls for notice in the present volume. Commencing with a short introduction, the body of the book falls into three divisions. The first treats of heterostyled plants, and contains in a connected form the substance of Mr. Darwin's various papers communicated to the Linnean Society. The second and third divisions are much shorter, and treat respectively of the passage of hermaphrodite into diœcious plants, and of cleistogamic flowers.

As has been already remarked, Mr. Darwin's researches on what are now termed heterostyled plants have been common scientific property for many years, and have filtered down into the current text-books. The seventh and eighth chapters are therefore the essentially new part of the book, and these we shall more particularly consider.

The vast majority of flowering plants are, as is well known, hermaphrodite, that is to say, they contain within the same floral envelopes both male and female organs. The governing principle in the morphological adaptations of flowers is apparently to escape the obvious consequences of such juxtaposition and evade self-fertilisation. This is effected either by their being dichogamic—that is the sexual organs in any one flower maturing at different times, or by their being entomophilous—that is calling in the intervention of insects to carry the pollen of one flower to the stigma of another, or by their being heterostyled—that is by the flower being modified in two or three ways, admitting of a certain number of reciprocal modes of fertilisation which are legitimate, and of others which are distinguished as illegitimate, and are more or less sterile.

Each of these modes of avoiding self-fertilisation practically sets up a functional separation of the sexes, and it might seem that the cases in which this separation is *structurally* accomplished are its natural sequence. Mr. Darwin points out, however, very conclusively that this is by no means the case.

"There is much difficulty in understanding why hermaphrodite plants should ever have been rendered diœcious. There would be no such conversion unless pollen was already carried regularly by insects or by the wind from one individual to the other, for otherwise every step towards diœciousness would lead towards sterility. As we must assume that cross-fertilisation was assured before an hermaphrodite could be changed into a diœcious plant, we may conclude that the conversion has not been effected for the sake of gaining the great benefits which follow from cross-fertilisation."

Mr. Darwin is led to find an explanation in the advantage to the plant in the diminished strain of producing sexual organs of only one kind instead of both. And the process of manufacturing diœcious plants is one which can be actually seen in process. The cultivated strawberry under the influence of the American climate is a marked instance. In such cases the hermaphrodite state can be traced into the diœcious with every intermediate grade. The ultimate fate of heterostyled plants is perhaps to be converted into diœcious ones, and in this instance the change would be more immediate and with fewer connecting links. The functional diversity already exists and the corresponding suppression of the sexual organs is all that is needed to render it complete.

The concluding chapter on cleistogamic flowers certainly does not yield in interest to any preceding portion of the book. The existence of these curiously-modified structures has long been known, but it is only within the last twenty years that they have been attentively studied, and Mr. Darwin's account is a very masterly discussion of all that has been written on a very puzzling subject, tested

and enriched by his own observations and experiments. As their name implies, these flowers never open, and in some cases they have been passed over as abortive bud-conditions of flowers of the normal conspicuous type. Their petals are, of course, superfluous, and are usually completely suppressed, or nearly so, the stamens and pistil are also much reduced in size, but though morphologically reduced, are physiologically fully developed, and such flowers are very fertile. In fact, in some instances, as in *Viola canina*, the production of seed is principally dependent upon them, the ordinary flowers, from want of pollen, or the absence of the visits of bees, rarely producing capsules.

At first sight the suggestion seems a tempting one, that in these curiously degraded flowers, in which all the laboriously-acquired adaptations for cross-fertilisation are entirely discarded, we have a reversion to a less highly organised ancestral type. And this may still to some extent be true, though Mr. Darwin shows that they "owe their structure primarily to the arrested development of perfect ones." In some cases, as Oliver has shown in *Campanula colorata*, and Scott in *Eranthemum ambiguum*, the same plant bears as well as cleistogamic and perfect flowers, intermediate forms between the two. What is, however, still more significant, is that the cleistogamic flowers are themselves sometimes the starting point of structural adaptations, to effect more perfectly the self-fertilisation which ordinary flowers have been so marvellously modified to avoid. Thus, in *Specularia perfoliata* the rudimentary corolla is modified into a perfectly closed tympanum, and in *Viola canina* the pistil is much modified. Mr. Darwin, however, has shown that cleistogamic flowers do not invalidate the general principle as to the disadvantage in the long run of self-fertilisation. After two years' growth, crossed seedlings of *Ononis minutissima* beat those produced from cleistogamic flowers in mean height in the ratio of 100 to 88.

It seems that the end really gained by cleistogamic flowers is the production of a large supply of seeds with little expenditure; the plant does the work more cheaply and makes the numbers pay. It is curious to reflect what, relatively speaking, an enormous expense a plant puts itself to in such a case as *Viola* in producing in the spring a large number of conspicuous flowers furnished with nectaries and all the complicated apparatus needed to insure cross-fertilisation, with the result, perhaps, of securing a very few cross-fertilised capsules. Having made these sacrifices, it proceeds during the summer to insure the production of a sufficient crop of less costly seeds by the inconspicuous aid of cleistogamic flowers.

Mr. Darwin, with characteristic ingenuity, adduces another instance of this balancing of conflicting advantages in the effort to secure before all things the perpetuation of the race. A seed in the ground—to parody a common proverb—is worth a good many exposed to depredation above it; and though dissemination is a gain, secure sowing is no less important. Many cleistogamic plants, therefore, having deliberately given up the advantage of cross-fertilisation, give up those attaching to change in the place of growth, and bury their fruits even before they are mature. This is the case with *Viola odorata* and *hirta* and *Oxalis Acetosella*. In other instances—and Mr. Darwin will pardon the remark that he has scarcely dwelt on the distinction—the buried fruit is the product of *subterranean* flowers. This is the case with *Vandellia sessiflora*, *Linaria spuria*, *Vicia amphicarpos*, *Lathyrus amphicarpus*, and *Amphicarpæa*, the three last cases belonging to *Leguminosæ*. The distinction is important because, while flowers produced under such abnormal circumstances as on subterranean branches must be necessarily cleistogamic, it by no means follows that aerial flowers which subsequently bury their fruits should also be cleistogamic, and Mr. Darwin very properly excludes the well-known earth-nut (*Arachis hypogæa*) from his list, as, though the ovaries are buried, the flowers are conspicuous. In such cases it is possible that the comparative humidity of the soil favours the maturation of the capsules, and especially so with small herbaceous plants in dry climates. Mr. Bentham in fact has pointed out in the case of *Helianthemum* that a prostrate habit which brings the capsules in contact with the surface of the ground postpones their maturity, and so favours the seeds attaining a larger size. *Cyclamen* (in every species except *C. persicum*), by the spiral contraction of its peduncle, brings its capsules down to the surface of the soil, though it does not appear to actually bury them, as some authors have supposed to be the case. If this is advantageous we need not wonder that the local amphicarpic races of *Lathyrus sativa* (of which there seem to be several) found in such dry countries as Portugal on the one hand, and Syria on the other, should acquire the habit of bearing actually subterranean fruit.

The steps, however, by which such a specialised mode of burying the fruit has been attained as exists in *Arachis*, are not easy to follow. Of few plants have the structure and habit been more misunderstood. Descriptive writers, from Rumphius to Endlicher, have represented it as having two kinds of flowers—and as being in fact what Mr. Darwin would call andromonœcious. It really, however, appears according to the careful examination of Poiteau and Bentham to have only flowers of one kind. These are apparently stalked, but the long stalk is in reality the attenuated calyx tube, which is a very peculiar feature for a leguminous plant. At the bottom of the calyx tube is the ovary which, after fertilisation, is gradually carried away by the development of a gynophore or subovarian stalk. It is the elongation of this gynophore—and not as Mr. Darwin states, by an oversight, the flower-stems drawing the flower beneath the ground—which buries the ovary. The careful observations of Correa de Mello show that though the gynophore may become three to four inches long, the ovary does not enlarge till it is buried, which confirms what has been said above as to the meaning of the habit generally. The details of the process by which the gynophore manages to bury the ovary would be a most interesting subject for investigation.

The obscurity which has attached to *Arachis* has also extended to *Voandzeia*, another leguminous plant cultivated like *Arachis* in hot countries for its subterranean pods. Mr. Darwin remarks that the perfect flowers are said never to produce fruit (pp. 327 and 341). Correa de Mello, however, never succeeded in detecting the cleistogamic flowers, and declares that it is "placed beyond all doubt that the hermaphrodite petaliferous flowers *do*

produce fruit."[1] Perhaps therefore *Voandzeia* may have to be expunged from the list of cleistogamic plants, while on the other hand *Krascheninikowia*, according to a thoughtful criticism of Mr. Darwin's book in the *Journal of Botany*, must be restored to it.

It may also be noted that according to Bentham *Martinsia* was a genus founded on a cleistogamic state of *Clitoria glycinoidis; Cologania* also should possibly be added to the list since Zuccarini's *Martia mexicana* appears to be an apetalous condition of some species of the genus.

Although the habit of producing cleistogamic flowers is pretty widely diffused amongst flowering plants it is locally concentrated in particular groups. This is particularly true in the case, as Mr. Darwin has pointed out, of *Malpighiaceæ* and *Acanthaceæ*, and amongst *Leguminosæ* in the *Glycineæ*. The genus *Viola* is remarkable in this respect; it is rich in cleistogamic species except in the section *Melanium*, to which *V. tricolor* belongs. In this species, besides conspicuous flowers adapted for self-fertilisation, smaller and less conspicuous flowers adapted for self-fertilisation are produced. These are not closed, but, as Mr. Darwin points out, "they approach in nature cleistogamic flowers," and though they differ in being produced on distinct plants they are perhaps destined to be as completely modified as the self-fertilising flowers of other sections of the genus.

The question as to the causes predisposing to the production of cleistogamic flowers is one of very great interest. In the first place Mr. Darwin points out that the larger proportion of known cases belong to plants with irregular flowers, that is, to plants whose flowers have been adapted for insect cross-fertilisation. Cleistogamy in this light is a resource to fall back upon when the elaborate adaptations for making insects do their work fail, as they seem to do more or less in *Viola*. It is a remarkable contrast that in heterostyled flowers, which are absolutely dependent upon insects for their legitimate fertilisation, irregular flowers are extremely exceptional, the adaptation, as far as it goes, being so complete that anything further in that direction is superfluous.

Four cleistogamic genera are normally wind-fertilised, and this shows that the cause alluded to above must be a subordinate one. Mr. Darwin urges with much force as the most potent agency, the unfavourable influence of climatic changes. From the time of Linnæus, it has been observed that exotic plants may be fertile, though their flowers have never attained proper expansion, that is to say, for the nonce they have become cleistogamic and self-fertile. The same thing occurs on a large scale with *Juncus bufonius*, in Russia, which in some districts never bears perfect flowers, while in Liguria, *Viola odorata* never bears cleistogamic ones. It is perhaps, however, doubtful whether winter-flowering plants are absolutely sterile, since the well-known *Chimonanthus*, whose name records its habit, is known to fruit, though sparingly, in this country. The evidence is, however, strong enough to render it highly probable that plants which are normally cross-fertilised, are driven into the abasement of cleistogamy when their geographical limits are extended beyond the limits not favourable to their receiving visits from appropriate insects, or to their properly expanding their flowers.

Here our comments must cease, content for our part if they attract a few more readers to a most fascinating research.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Elements of Articulate Speech

As a corollary to the interesting observation with the phonograph recorded by Prof. Fleeming Jenkin and Mr. Ewing in the last number of NATURE, will you allow me to point out that every capital letter of the Greek alphabet except Γ and P is actually (either as written or when turned through an angle of 90°) a reversible or a reduplicate symbol.

With regard to gamma, although the capital is not, the small letter (γ) *is* reversible; and as to P (or R, which is another ancient Greek form of it), many facts seem to show that by itself it does not as a rule represent a complete part of articulate speech; witness its frequent reduplication in Greek, the aspirate so often employed with it both in Greek and Latin, and the way in which it is frequently omitted, as if of no importance, from Latin words ordinarily spelt with it. The French or Italian pronunciation of this letter amounts to a reduplication in the English ear, while the English pronunciation of it amounts to its omission altogether in the ear of a Frenchman, an Italian, or a Scotchman.

In the Roman alphabet F, G, L, P, and R, are the exceptions; much might be said about each of these, but I will content myself by saying that L is obviously only an apparent exception, as it is easily derived from Λ. W. H. CORFIELD

10, Bolton Row, Mayfair, March 30

Phoneidoscopic Representation of Vowels and Diphthongs

I HAVE just obtained the two following results with the phoneidoscope[1]:—

1. If a vowel be steadily sung on a single note, a constant colour-figure is produced; but if the vowel be spoken in the ordinary conversational tone, a change of figure occurs before the sound ceases. The slurring alteration of pitch which takes place in pronouncing a single vowel is thus rendered perceptible by the eye.

2. When a diphthong is slowly intoned, two distinct figures successively present themselves, which are found on trial to be those corresponding to its constituent vowel-sounds. The twofold nature asserted in the word "diphthong" receives by this experiment a visible illustration. SEDLEY TAYLOR

Trinity College, Cambridge, April 1

The Southern Drought

YOU ask in last week's NATURE (p. 436) for information respecting the drought in the southern hemisphere. A few days ago I received letters from Samoa and the Gilbert Islands telling me of its severity there. Droughts are of frequent occurrence in the Gilbert Islands, but my correspondent (a native of Samoa) tells me they have had an extraordinary one there, which commenced in 1876, and which continued up to the date of his letter—December 4, 1877. He says many of the people have died from starvation in consequence.

A letter from a missionary who has been forty years in Samoa contains the following:—"We have had the greatest drought I have ever known." The Samoan Islands are wonderfully fertile, and even during what is called the dry season it is rarely that more than a fortnight passes without rain. The atmosphere is always full of moisture, and there are very heavy dews at night, so that the vegetation never gets burnt up, except the drought be very extraordinary. Now, however, my correspondents speak of scarcity of food in those most fertile islands.

Blackheath, March 29 S. J. WHITMEE

[Can our correspondent favour us with the date of the last droughts or series of droughts?—ED.]

[1] *Journ. Lin. Soc.*, Bot xi. p. 256.

[1] See NATURE, vol. xvii. p. 426, note 2.

Cumulative Temperatures

In reference to my letter upon the above subject, which was published in your columns of February 21 last, I have received from Prof. de Candolle, of Geneva, a communication dated March 11, in which he calls attention to the fact that in his "Géographie Botanique raisonné," which was published as far back as the year 1855, he recorded the suggestion (made by himself some ten years previously) of the employment of an uncompensated pendulum fitted with a suitable registering apparatus for the determination of cumulative temperatures in connection with the application of meteorology to agriculture and to the geography of plants.

In the above work (vol. i. pp. 58 and 59) the following passage occurs:—

"Les chiffres les plus importants à connaître pour les applications de la météorologie à l'agriculture et à la géographie botanique sont, pour chaque localité, les sommes de température au dessus de + 1°, + 2°, de + 3°, etc., par année, saison, mois ou fraction de mois.

"Pourrait-on obtenir ces valeurs directement par un instrument spécial, qui dispenserait de recourir à des calculs compliqués, souvent impracticables, dans le système actuel des observations météorologiques? C'est une question que je soumets aux physiciens. Elle m'a préoccupé depuis longtemps, mais je suis loin de posséder les connaissances théoretiques et pratiques nécessaires pour arrivir à une solution. J'entrevois la possibilité de construire deux sortes d'instruments qui répondraient aux conditions désirées; je les mentionne sans pouvoir indiquer les détails d'exécution.

"L'un de ces instruments serait la pendule-thermomètre de M. Edmond Becquerel, modifié de telle sorte que les battements par une température inférieure à 0°, ou ceux inférieures à + 1°, à + 2°, etc., ne seraient pas comptés."

"Un autre système serait celui de thermomètrographes marquant les températures supérieures à tel ou tel degré, et seulement celles-là."

To this the following foot-note was added:—"Il y a plus de dix ans je fit des démarches auprès de deux astronomes, M. Gautier, à Genève, et M. Arago, à Paris, pour appliquer la pendule à la mesure des températures. Je proposais une pendule aussi dilatable que possible sous l'action de la température et un compteur adapté à l'instrument. . . . Les honorables savants auxquels je m'etais adressé penserent qu'il serait trop difficile de soustraire l'instrument à diverses causes d'erreurs."

From the above, which was written twenty-three years ago, it is clear that to the eminent botanist must be accorded the merit of priority not only of the suggestion but also of the publication of the idea of the method of averaging temperatures by observations of the pendulum, while to Mr. Stanley must be given the credit of embodying that idea in a practical form and constructing an instrument based upon the principle.

St. Leonards-on-Sea, March 16 CONRAD W. COOKE

The Wasp and the Spider

I HAD anticipated in my own mind Mrs. Hubbard's suggestion, and only the great pressure on your space prevented my meeting it in my previous letter. In the first place, my recollection is that the spider was of a kind that spins no web; like our own grey hunting spider, familiar in the summer on walls and palings. In the next place no species of spider, except the gossamers, habitually leaves this fine line behind it. It is in all cases a voluntary act, preceded by a perceptible pause, and pressure downwards of the extremity of the body to attach the end, whether for suspension, or in the process of forming the web. Even the gossamers are no exception to this rule; only in their case the line, in summer and autumn, is more continuously run out as a point of departure for their mysterious aërial flights. A house-spider, for instance, as he runs across the floor or across your hand, leaves no fine line behind him. The tiny gossamer has an amazing command of the material, but in the larger, web-spinning kinds it is far from inexhaustible, and, at all events, an apparently useless waste is not in the ordinary economy of nature. Moreover, in the case in question the spider was keenly aware he was pursued, and would not willingly leave so fatal a clue on his track. Mr. Merlin, who is on the list for 1878 as our consul for the Piræus, is, however, a competent observer, and could settle the question. HENRY CECIL

Bregner, Bournemouth, March 23

SUN-SPOTS AND RAINFALL

BY the overland mail which arrived here on January 12, I received, through the courtesy of Dr. W. W. Hunter, two copies of a pamphlet on "The Cycle of Drought and Famine in Southern India," a copy of the *Nineteenth Century* for November, and a copy of a letter on "The Rainfall in the Temperate Zone in Connection with the Sunspot Cycle," published in NATURE (vol. xvii. p. 59).

Having previously read notices of the pamphlet and being desirous to see it, I requested its author to favour me with a copy. His rainfall cycle for Madras was, so far as I could learn from newspaper reports, identical with a cycle which I had discovered long before. In my official report for 1875, which was printed and circulated in 1876, I gave a *résumé* of the results at which I had arrived from 1872 down to the close of 1875, and stated that an examination of returns from 144 stations in different parts of the world, as well as of the variations in the levels of European rivers, had led me to the conclusion that there was a rainfall cycle of the same duration as the sunspot cycle and nearly coincident with it, both the sunspots and the rainfall attaining a minimum in the eleventh, first, and second years of the cycle, and a maximum in the fifth year. Hence when I learned from an abstract of Dr. Hunter's results for Madras that in his "cycle of eleven years both the sunspots and the rainfall reach their minimum in the group consisting of the eleventh, first, and second years, and that both the rainfall and the sunspots there increase till they both reach their maximum in the fifth year," I was curious to know how his cycle had been made out; for although I had not the Madras rainfall for each year from 1813 to 1872, yet from the falls in the years of maximum and minimum sunspots which I got in the *Proceedings* and *Transactions* of the Institution of Civil Engineers (vol. xxxii.), I inferred that the Madras rainfall was not quite so favourable to my hypothesis as the rainfalls of some other places. As, however, I might be wrong, I applied for a complete table of the Madras rainfall, but without success.

A remarkable rainfall cycle for Bombay, nearly coincident with the sun-spot cycle, had been previously ascertained, and a similar cycle, though not so well marked, had also been found by comparing the yearly mean rainfalls of Anjarakandy, Bombay, Calcutta, and Nagpur with Wolf's relative sun-spot numbers.

I have now the whole history of the Madras cycle before me. The author of the pamphlet says that after many experiments he hit upon a method of working out a cycle. This method consisted in commencing with 1876, taking backwards, as far as the register extended, periods of eleven years each, and then finding the mean rainfall for each series of years in the common period.

The results obtained for Madras by this method are to a considerable extent in conformity with those which I had found for different countries; but there are discrepancies, one of the most remarkable of which is that the rainfall in the second year of Dr. Hunter's cycle is greater, instead of less, than the mean rainfall. Still there is a certain amount of coincidence. But as the method used by Dr. Hunter—and I would call special attention to this point—is different from the one by which I found my cycle, his results and mine are not comparable.

The sun-spot cycle being one of about eleven years, and the maximum epoch occurring, on an average, 3·7 years after the previous minimum, and the next minimum 7·4 years after the maximum, I found by experience that the best way of comparing the rainfall and the sun-spots was to start either from a maximum or a minimum year, and then to take the proper number of years before and after the epochal year. Commencing with a maximum year, for instance, I took five years before it and seven

years after it, or thirteen years in all. Then, with the view of reducing the effects of the so-called non-periodic variations, I took a mean of the rainfall in the first and third of the thirteen series, and a mean of that mean and of the rainfall in the second series, and so on. This gave me eleven new means, which I called the "mean cycle." Again, starting with a minimum year, I took eight years before it and four years after it, and found eleven other new means in the same way. To each set of results, or to a combination of both of them, I then applied interpolation formulæ, and found a well-marked coincidence between the sun-spot and rainfall variations.

As the sun-spot cycles are not all of the same length, it is evident that by starting from any one year and going backwards over a long period, always using the same fixed number, a maximum and a minimum year might fall into the same group.

Let me, by an example, explain my method more fully. I take the Madras rainfall :—

TABLE I.—*Rainfall Cycle at Madras.*

Years.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
	in.	in.	in.	in.	in.	in. max. years.	in.	in.	in.	in.	in.	in.	in.
1811-23	—	—	45.11	32.41	56.00	41.16	63.56	76.25	36.33	70.01	47.13	59.61	26.62
1824-36	33.72	56.05	60.71	88.41	37.89	36.87	32.43	44.35	18.45	37.11	39.00	41.47	44.76
1832-44	18.45	37.11	39.00	41.47	44.76	49.26	52.33	53.07	58.65	58.32	36.48	50.28	65.36
1843-55	50.28	65.36	38.05	79.81	80.99	54.76	39.81	36.88	64.32	72.69	35.82	43.20	32.32
1855-67	32.32	46.99	52.95	48.50	55.14	27.64	37.19	38.18	54.61	47.23	41.64	51.39	24.37
Means	33.69	51.38	47.17	58.12	54.96	41.94	45.06	49.75	46.47	57.07	40.01	49.19	38.69
Mean Cycle	—	46.12	50.96	54.59	52.49	45.97	45.55	47.75	49.94	50.15	46.57	44.52	—
Rainfall Variation	—	– 2.48	+ 2.36	+ 5.99	+ 3.89	– 2.63	– 3.05	– 0.85	+ 1.34	+ 1.55	– 2.03	– 4.08	—
Sun-spot Variation	—	– 32.3	– 19.2	– 1.1	+ 30.2	+ 40.0	+ 29.8	+ 11.3	– 1.2	– 12.8	– 21.1	– 23.6	—
Years of Cycle...	—	1	2	3	4	5	6	7	8	9	10	11	—

It will be seen that the individual years of maximum sunspots, 1816, 1829, 1837, 1848, and 1860, are all in the same vertical column, and that all the years of minimum sun-spots, except 1810, contribute to the formation of the beginning and end of the cycle. No doubt it would have been better to have placed 1836 farther in advance, but this would have altered the position of the maximum year 1829.

The results given by the above method show a *double* oscillation of the Madras rainfall during the sun-spot period, and I see (NATURE, vol. xvi. p. 333) that Mr. J. Allan Broun has found such an oscillation for Trevandrum as well as for Madras, and this may be a characteristic of the rainfall of the whole of Southern India. We have, however, evidence of a single rainfall oscillation for other parts of India. Even Mr. Blanford now admits that there is a periodic variation underlying all irregularities and more or less coincident with the sun-spot variation.

In consequence of the method adopted by Dr. Hunter the years of maximum sun-spots, in place of being all in the same group, are spread over three or four of the groups from which he derived his mean cycle, and it is probably owing to this that he missed what, I think, is the real character of the rainfall cycle at Madras, as shown in Table I. The annual average rainfall for each year of his cycle, together with the deviations from the mean, is as follows, and it will be seen that his cycle is very different from the one given by my method :—

Years of Cycle.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Average Rainfall ...	in. 49.15	in. 35.00	in. 49.08	in. 49.17	in. 58.33	in. 50.95	in. 50.37	in. 54.35	in. 52.88	in. 45.16	in. 37.03
Rainfall Variation ...	+ 0.84	– 13.31	+ 0.77	+ 0.86	+ 10.02	+ 2.64	+ 2.06	+ 6.04	+ 4.57	– 3.15	– 11.28

According to Dr. Hunter's cycle, the rainfall of Madras was in excess in the fifth year to the extent of *ten* inches, whereas, according to mine, it was nearly *three* inches in defect. He takes, it is true, the years 1868-76, which I do not take, preferring to wait till I get the rainfall of 1877; but although 1870, which he puts down in his fifth group, was a very wet one, the double oscillation still exists, one of the minima occurring soon after the sun-spot maximum.

I must now come to Dr. Hunter's letter in NATURE (vol. xvii. p. 59). But, first of all, I may be excused for saying that I do not think some remarks he made about a periodicity of cyclones in a former letter (vol. xvi. p. 455) were altogether calculated to put the matter in its proper light. He says (p. 456) :—" M. Poëy called the attention of the French Académie des Sciences to the subject five years ago, and published, as far back as 1873, a list of hurricanes in the West Indies from 1750 to 1873, in support of *his* views. Dr. Meldrum has worked the same question as regards the [East] Indian Ocean." Now if these words are meant to convey the impression that M. Poëy preceded me, and that I followed with the cyclones of the Indian Ocean, all I can say is that M. Poëy himself gave a different version of the matter.

In his second letter (vol. xvii. p. 59) Dr. Hunter states

(1) that the evidence with respect to the European rainfall may be considered as "against a well-marked periodicity," and (2) that the result of a "systematic inquiry (by himself) into the American rain-returns altogether fails to establish the existence of a common cycle, so far as concerns the temperate zone." On each of these points I beg to make a few remarks.

The evidence on which Dr. Hunter bases his statement as to the European rainfall is derived (1) from an examination by Mr. Baxendell, for a short period, of the rainfall at *one* English station, (2) from an examination by the late Dr. Jelinek of *fourteen* stations on the Continent, from 1833 to 1869, and (3) from a comparison of the levels of the Elbe, Rhine, Oder, Danube, and Vistula, with the sun-spots for six cycles, a comparison which Dr. Hunter ascribes to Herr Gustav Wex, but which I believe is due to another.

Now, the evidence is much more extensive. Instead of being based on one British station and fourteen stations on the Continent, it is based on more than fifty British stations and more than forty stations on the Continent, and, taken with the evidence furnished by the rivers, it is, in my opinion, conclusive.

As to the American rainfall, an examination of thirty-four returns has given me much more favourable results than those Dr. Hunter has got from twenty-two stations, and I have little doubt that he will, as he extends his investigations, also find favourable results; but I think he must first adopt a method different from the one he used for Madras.

In support of my conclusion that the rainfalls of Europe and America are subject to a periodicity which closely corresponds with the sunspot periodicity, I will for the present only submit to your readers two tables, the one showing the general results for Great Britain, the Continent of Europe and America, and the other the results for one station in each of these countries, namely Edinburgh, Paris, and New Bedford.

TABLE II.—*Comparison of the Variation in the Sun-spot Area with the Variations in the Rainfalls of Great Britain, Continent of Europe, and America, from 1824 to 1867 inclusive.*

Years of Cycle.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Sun-spots	– 31·7	– 19·5	+ 3·5	+ 28·8	+ 39·5	+ 29·5	+ 10·4	– 4·9	– 14·8	– 21·2	– 19·4
Rainfall of Great Britain	– 2·22	– 1·67	+ 0·04	+ 1·16	+ 1·05	+ 1·46	+ 1·28	+ 0·89	+ 0·43	– 0·73	– 1·03
Rainfall of Continent of Europe	– 0·76	– 1·73	– 1·22	+ 0·44	+ 1·18	+ 0·97	+ 1·08	+ 0·60	– 0·45	– 0·36	+ 0·62
Rainfall of America...	– 2·73	– 0·88	+ 0·91	+ 0·53	+ 0·24	+ 1·34	+ 2·03	+ 0·84	– 0·27	– 0·66	– 1·24
Mean Rainfall Variation	– 1·90	– 1·43	– 0·09	+ 0·71	+ 0·82	+ 1·26	+ 1·46	+ 0·78	– 0·10	– 0·65	– 0·55

The above results have been obtained in the manner in which I obtained the rainfall variation in Table I. For Great Britain the number of stations is 54, for the Continent of Europe, 42, and for America, 32.

TABLE III.—*Comparison of Variation in Sun-spot Area with Variations in Rainfalls of Edinburgh, Paris, and New Bedford, from 1824 to 1867 inclusive.*

Years of Cycle.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Sun-spots	– 31·7	– 19·5	+ 3·5	+ 28·8	+ 39·5	+ 29·5	+ 10·4	– 4·9	– 14·8	– 21·2	– 19·4
Rainfall of Edinburgh	– 3·02	– 1·66	– 0·64	+ 2·50	+ 3·45	+ 2·86	+ 0·64	– 0·27	– 0·91	– 2·36	– 0·56
Rainfall of Paris ...	– 0·25	– 0·61	– 0·30	+ 1·27	+ 2·22	+ 1·90	+ 1·49	– 0·84	– 1·42	– 0·94	+ 0·48
Rainfall of New Bedford	– 3·07	– 1·03	– 0·69	– 0·32	– 0·19	+ 1·38	+ 3·47	+ 2·87	– 0·32	– 1·42	– 0·68
Mean Variation of Rainfall...	– 2·11	– 1·10	– 0·54	+ 1·15	+ 1·83	+ 3·05	+ 1·87	+ 0·59	– 0·88	– 1·57	– 0·25

It will be observed (see Table I.) that the variation in the Madras rainfall is not nearly so favourable as the variations for Edinburgh, Paris, and New Bedford.

What I have given here is but a small portion of the evidence in favour of a rainfall cycle. Having worked at the subject for six years, I have concluded that the whole evidence is as satisfactory as the evidence of a connection between sun-spots and terrestrial magnetism.

C. MELDRUM

Mauritius, February 1

JULIUS ROBERT VON MAYER

SEVERAL years ago (vol. v. p. 117) we published a paper by Prof. Tyndall on the nature and value of Mayer's researches, in which they were so fully detailed that now, on the occasion of the death of the man whose labours have won for him an undying renown, we need only briefly remind our readers of the chief events in his scientific career without entering into or attempting to renew a painful controversy of which it may be said that the truth lay neither wholly with one side nor the other.

Julius Robert Mayer was born at Heilbronn, November

25, 1814. In the neighbouring University of Tübingen, he underwent the usual course of studies in the medical faculty; and after obtaining his degree as physician, passed some time in the hospitals of Münich and Paris. His entrance into professional life was as ship's surgeon on an East India vessel. While thus engaged he made an observation apparently unconnected with, but really the origin of, all his subsequent investigations. To quote from Prof. Tyndall's paper referred to:—

"In the summer of 1840, he was at Java, and there observed that the venous blood of some of his patients had a singularly bright red colour. The observation riveted his attention; he reasoned upon it, and came to the conclusion that the brightness of the colour was due to the fact that a less amount of oxidation sufficed to keep up the temperature of the body in a hot climate than in a cold one. The darkness of the venous blood he regarded as the visible sign of the energy of the oxidation. It would be trivial to remark that accidents such as this, appealing to minds prepared for them, have often led to great discoveries. Mayer's attention was thereby drawn to the whole question of animal heat. . . ."

It was the idea thus suggested which he worked out to its issue in his great generalisation. In 1841 he returned from Batavia, and settled in his native town. Here he devoted the spare hours from his professional duties to the consideration of various unsolved physical problems. Although almost entirely isolated from scientific companionship, with next to no opportunity for experimental research, and limited in time, he evolved in a short period a succession of theoretical views, which in point of originality, boldness, and comprehensive grasp of facts, stand among the foremost in the history of physics. Mayer's first contribution to scientific literature—"Ueber die Kräfte der unbelebten Natur"—appeared in Liebig's *Annalen* in 1842, and contained within the space of eleven pages the forecast of the mechanical theory of heat, as accepted at present. At this time the caloric theory still found numerous advocates, despite the classic experiments of Rumford, of Davy, and of others; and but a small minority ventured to defend, from one standpoint or another, the idea of an intimate connection between heat and motion. It was reserved for Mayer to sum together the scattered facts, and to mould from them definite views on the nature of heat. With his introduction of the expression "the mechanical equivalent of heat," and the clear exposition of the mutual interchangeability of heat and mechanical energy, he dealt the last blow to the old theory, and thus largely helped to place on a firm foundation the new doctrines of the conservation and transformation of energy. But in this Mayer did not stand alone, nor was he the only one who had a firm hold of the conceptions which have been so fruitful of result. The quiet sap of experiment was going on side by side with these daring reconnaissances beyond the borders of the known and proved, and our own Joule, whose work does not suffer because he was not the sole worker and thinker in the field, was conducting those researches which have earned for him also an undying name and fame.

Three years elapsed before the appearance of Mayer's next work in 1845, on "Organic Movement in Connection with the Transformation of Matter." In this *brochure* of 100 pages, he details at greater length the new theory, and with a most extensive, varied, and novel series of illustrations from every branch of natural science and natural history, establishes the principles that all the so-called forces are interchangeable forms of energy—the one sole force—that energy is never created or destroyed, and that all natural phenomena are accompanied by a change of the form of energy. The logical consequences of the mechanical theory of heat were followed to their uttermost limits in Mayer's work "On Celestial Dynamics," in 1848. Here he seeks to solve the difficult problems of determining the thermal effects of the movements in the universe, the maintenance of the supply of solar heat, &c. One chief source of the latter he considers to be the heat evolved by the fall of innumerable meteorites &c., into the sun.

His "Remarks on the Mechanical Equivalent of Heat," in 1851, was his last notable contribution to the development of this subject. It possesses the same fulness of original ideas as its predecessors, and in point of vividness and clearness of conception and definition, can only be rivalled by Tyndall's "Heat as a Form of Motion." A collected edition of his writings, under the title of "Die Mechanik der Wärme," appeared at Stuttgart, 1867, and a second edition in 1874; this was followed by "Naturwissenschaftliche Vorträge" (Stuttgart, 1871), and two papers under the title of "Die Torricelli'sche Leere" and "Über Auslösung" (Stuttgart, 1876). The controversy on the priority of his discoveries led to disturbances in the mental health of the great *savant*, which, however, was in time completely restored. Dr. Mayer was of an original and witty turn of mind, unrestrained in a small company, but otherwise modestly retiring within himself.

In measuring the value of Mayer's scientific achievements it must not be forgotten that he published his theory at an epoch when physicists were directing their attention especially to this very subject, and that in Denmark and England the experiments were well advanced, which led to the complete establishment of our present knowledge of the character of heat and energy. It is, however, difficult to believe that any of his rivals in this province could have developed and amplified the theory in the masterly manner shown by this obscure German physician. In perusing his works, one scarcely knows which to admire most, the wonderful powers of classification and breadth of knowledge exhibited in every page, or the charming simplicity, clearness, and aptness of illustration with which abstruse theoretical questions are put within the comprehension of a tyro in science. Certainly in view of his life and surroundings, the contributions of Mayer to the progress of physics occupy a unique position in the history of science. To quote Dr. Tyndall again—

"Mayer grasped the mechanical theory of heat with commanding power, illustrating it and applying it in the most diverse domains. He began, as we have seen, with physical principles; he determined the numerical relation between heat and work; he revealed the source of the energies of the vegetable world, and showed the relationship of the heat of our fires to solar heat. He followed the energies which were potential in the vegetable up to their local exhaustion in the animal. But in 1845 a new thought was forced upon him by his calculations. He then for the first time drew attention to the astounding amount of heat generated by gravity where the force has sufficient distance to act through. He proved, as I have before stated, the heat of collision of a body falling from an infinite distance to the earth, to be sufficient to raise the temperature of a quantity of water equal to the falling body in weight 17,356° C. He also found in 1845 that the gravitating force between the earth and sun was competent to generate an amount of heat equal to that obtainable from the combustion of 6,000 times the weight of the earth of solid coal. With the quickness of genius he saw that we had here a power sufficient to produce the enormous temperature of the sun, and also to account for the primal molten condition of our own planet. Mayer shows the utter inadequacy of chemical forces, as we know them, to produce or maintain the solar temperature. He shows that were the sun a lump of coal, it would be utterly consumed in 5,000 years. He shows the difficulties attending the assumption that the sun is a cooling body; for supposing it to possess the high specific heat of water, its temperature would fall 15,000° in 5,000 years. He finally concludes that the light and heat of the sun

are maintained by the constant impact of meteoric matter. I never ventured an opinion as to the accuracy of this theory; that is a question which may still have to be fought out. But I refer to it as an illustration of the force of genius with which Mayer followed the mechanical theory of heat through all its applications. Whether the meteoric theory be a matter of fact or not, with him abides the honour of proving to demonstration that the light and heat of suns and stars *may* be originated and maintained by the collisions of cold planetary matter."

His services were recognised by election to membership in the French Academy of Sciences and other foreign societies, and two years before his death the King of Würtemberg elevated him to the nobility. Mayer received the Copley Medal of the Royal Society in 1871.

OUR ASTRONOMICAL COLUMN

TOTAL SOLAR ECLIPSES.—The eclipse of the sun on July 29, in which the belt of totality traverses the North American continent from Behring's Strait to the Gulf of Mexico, is a return of the eclipse of June 16, 1806, which was observed in the United States by Bowditch and the well-known Spanish astronomer, Ferrer; in this year it was central, with the sun on the meridian in 65° 30' W., and 42° 23' N., and the duration of total eclipse exceeded five minutes. At its next return on June 27, 1824, it was total at apparent noon in 170° 4' W., and 44° 42' N., but the course of the central eclipse was almost entirely an ocean-track. In 1842, on July 8, the total phase passed over the south of Europe, and was observed by a great number of astronomers, amongst them by the Astronomer-Royal at the Superga, near Turin, and by Baily, at Pavia, and Arago, who was stationed at Perpignan, gave a graphic account of the circumstances attending the extinction of sunlight, which has been often quoted. At the ensuing return of the eclipse in 1860, the "Himalaya" expedition was organised, and numerous descriptions of the phenomenon are upon record; one of the best of them is that given before the Royal Society, as the Bakerian Lecture, by Mr. de la Rue. American observers will doubtless render good account of the eclipse in July next. Its last return in the present century will take place on August 9, 1896, when it will be total soon after sunrise in the north of Sweden and Norway, central at apparent noon in 112° 21' E. and 65° 38' N. between Nova Zemlia and the mainland of Asia, ending in 179° 3' W. and 18° 35' N. in the North Pacific.

We have already given in this column some particulars of the total phase as it will occur in the present year in the United States. The last total eclipse visible in that country took place on August 7, 1869, and is the subject of detailed description in a very interesting appendix to the *Washington Observations*. The line of totality in the eclipse of January 11, 1880, will just reach American ground before sunset; some fifty miles south of Monterey, in California, the eclipse will be total for about forty seconds, but the sun will be at less than 2° altitude, thus affording a similar case to that which some interpreters of Herodotus have supposed to have occurred in the eclipse of Thales at the site of the battle between the Medes and Lydians when "day was suddenly turned into night;" though of course a characteristic of every total eclipse, it does not frequently happen that after a long ocean track the total phase is just landed on the coast of a continent at sunset. But although January, 1880, will witness what is strictly the next total eclipse of the sun on the soil of the United States, it does not appear that there will be one favourably circumstanced for observation until the year 1923, on September 10. As it is possible some readers may be interested in seeing the particulars of this eclipse, in connection with the phenomenon in July next, or as the next following eclipse in which totality can be well observed in any part of the North American continent, we give elements, &c., here, derived upon a similar system of calculation to what has been applied to other eclipses in these columns.

G.M.T. of conjunction in R.A. 1923, Sept. 10, at 8h. 28m. 42s.

	°	′	″	
Right Ascension	168	6	55·4	
Moon's hourly motion in R.A. ...		34	53·8	
Sun's " " " ...		2	14·9	
Moon's declination	5	38	34·0	N.
Sun's "	5	6	14·5	N.
Moon's hourly motion in decl. ...		11	5·1	S.
Sun's " " " ...		0	56 8	S.
Moon's horizontal parallax		59	55·3	
Sun's " "			8·8	
Moon's semi-diameter		16	19·7	
Sun's " "		15	53·7	

Hence the central and total eclipse commences at 7h. 15·6m. in long. 154° 38′ E., lat. 48° 24′ N.; it falls with the sun on the meridian in 127° 54′ W., and 38° 5′ N., and ends at 10h. 15·7m. in 63° 25′ W., and 13° 50′ N. The following are also points upon the line of central eclipse:—

Long.	Lat.	Zen. Dist.	Long.	Lat.	Zen. Dist.
° ′	° ′	°	° ′	° ′	°
120 13 W.	... 34 0 N.	...31·1	106 12 W.	... 26 22 N.	...40·7
116 52	... 32 18	...33·1	94 33	... 20 55	...54·9
112 25	... 29 47	...34·7	81 14	... 16 41	...71·1

Calculating directly for the first of these positions which is near the N.W. point of the island of Santa Cruz, off the Californian Coast, we find

Totality begins at 0h. 46m. 22s. }
" ends at 0h. 49m. 56s. } Local mean times.

The duration of the total eclipse on this coast will therefore be about $3\frac{1}{2}$ minutes, with the sun at an altitude of nearly 60°.

GEOGRAPHICAL NOTES

CHINA.—Lieut. Gill, R.E., who, a short time back, arrived in British Burmah, after succeeding in traversing China from Shanghai to the Yünnan frontier, has furnished a Rangoon paper with an account of his journey. Lieut. Gill, in the first instance, proceeded, *viâ* Hankow, to Chung-king, in Szechuen, whence he made a trip to the northwards, visiting the fire-wells of Tsi-liu, at which place are also found brine-wells, from which good salt is made. Mr. Gill made his way to Sung-pao-ting, on the borders of the Koko Nor, and to Liang-ngan-foo, returning by a different route to Chêng-tu. Being joined by Mr. Mesney, the two began their long, perilous, and arduous journey to Burmah overland, in the course of which they passed Bathang, on the borders of Thibet, in about N. lat. 30°. Near Bathang ranges were crossed which were some 15,600 feet in height. The most common tree near Bathang is the pine, which in some places was seen in magnificent forests, and many of the trees were found to be about three feet in diameter.

A correspondent of the *North China Herald*, writing from Chefoo, says that a scheme is under consideration for working the coal-mines of the province of Shantung, which is well known to be rich in mineral wealth. Some 120 miles to the west of Chefoo there is a fine level plain, under which at no great depth is a bed of coal twenty feet thick. The natives have from time immemorial been digging holes and getting a little out here and there, but as they have no means of drainage, the pits have filled with water as soon as they reached the good coal. The Chinese Superintendent of Customs at Chefoo, has obtained permission to form a native company to carry out the work, with the aid of modern appliances. The scheme referred to is understood to include a tramway to the port of Chefoo. Another project on a larger scale has been formed under the auspices of

the famous Li Hung-chang, for developing the coal and iron districts to the north-west of Tientsin, in the Chihli province. Should the enterprises we have alluded to be successfully carried out, some hopes may be entertained of a gradual development of the hidden resources of the Chinese Empire.

ANGOLA.—We learn that a young and energetic collector, Mr. Alfred Heath, started on board the *Biafra*, which sailed from Liverpool last Saturday, for the purpose of exploring the interior of Angola, and obtaining objects of natural history. Mr. Heath will stay at Ambriz for a short time, and make collections on the River Loge and on the coast, after which he will proceed inland to Bembe, a place recommended by the late Mr. Monteiro as presenting an excellent field for the naturalist.

AN ORGAN-PIANO

WHEN recently in Paris I was shown—I believe at the pianoforte factory of M. Herz—a piano with appliances for producing prolonged sounds like those of an organ, which appeared to me to be based on thoroughly sound scientific principles, and which was so great a success that, although the invention had only been perfected a very few weeks before, the firm were receiving orders for the new instruments much faster than they could execute them. The attempt to combine organ sounds with those of a piano has often before, I believe, been made, but usually, if not always, I am told, by combination with the piano arrangements of real organ appliances, the result being, of course, extreme difficulty in obtaining perfect harmony between notes produced by two such totally distinct methods. In the present instance the organ as well as the piano notes are produced by precisely the same means, the principle consisting in producing the organ or prolonged sound by a succession of extremely rapid blows of a hammer upon the same strings as produce the piano note. It will not be difficult, I think (notwithstanding my want of familiarity with such subjects), to make your readers understand exactly how this is accomplished. They will observe that if the pianist were able, instead of merely holding down a key, to produce upon it an extremely rapid succession of blows, far exceeding in rapidity anything which the finger can possibly effect, a prolonged note would be produced, and especially so if the number of blows given was so great as to be practically inseparable by the ear. Now in the instrument of which I am speaking this object is accomplished by means of a series of additional hammers (one to each string) mounted upon watch-spring levers, all of which are carried by a bar of brass lying across, but above and clear of the strings. To this bar is attached a rocking lever which is set in very rapid motion by means of an apparatus worked easily by a pedal. I was not shown the exact nature of this apparatus, but there are so many forms of small engines worked with immense rapidity by compressed air, any one of which would answer the purpose, that no great importance attaches to this point. The *modus operandi* is simple enough: the pianist works the pedal, and thus sets the transverse bar with its series of hammers into excessively rapid vibration. By holding down any key of the instrument, the string belonging to it is brought within range of its corresponding hammer, and is struck with corresponding rapidity, giving out what sounds at a short distance like one prolonged note, which lasts as long as the pedal is worked and the key is kept down. It is easy to see that by this means it is in the power of the pianist to produce either piano or organ notes at will, and although while standing close to the instrument the mode of production of the note could be detected, at a short distance the effect was precisely that of combined piano and organ sounds with the immense advantage of absolute concordance and harmony between the two.

E. J. REED

THE COMING TOTAL SOLAR ECLIPSE

WE have received from Admiral Rodgers, the Superintendent of the U.S. Naval Observatory, the official circular which we were enabled to anticipate some little time ago. Owing to the endeavours of the American astronomers, the Pennsylvania Railroad Company have made arrangements for a reduced rate of fare to and from the East to Denver, Colorado, which is near the central line. These arrangements refer only to persons going in a private capacity, and not to members of expeditions sent out by foreign Governments.

Upon the order of the Superintendent of the U.S. Naval Observatory, Washington, the Company will furnish transportation to Denver and return *viâ* Pittsburg, Indianapolis, St. Louis, and Kansas City, or *viâ* Pittsburg, Chicago, and Omaha, at the following rates for the round trip:—From New York, 73.00 dols.; from Philadelphia, 71.00 dols.; from Baltimore or Washington, 62.50 dols.

The round trip ticket includes transportation (about 2,000 miles according to route) from New York to Denver and back again to point of starting; or in all, 4,000 miles of travel.

These arrangements allow the journey to Denver to be made by one route, and the return by another. The routes available are—

No. 1, *viâ* Pittsburg, Chicago, Omaha, Denver.
No. 2, *viâ* Pittsburg, Chicago, Omaha, Denver.
No. 3, *viâ* Pittsburg, Chicago, Omaha, Denver. (Different routes from Chicago to Omaha.)
No. 4, *viâ* Pittsburg, Chicago, Leavenworth, Denver.
No. 5, *viâ* Pittsburg, Chicago, Atchison, Pueblo, Denver.
No. 6, *viâ* Pittsburg, Indianapolis, St. Louis, Kansas City, Denver.
No. 7, *viâ* Pittsburg, Indianapolis, St. Louis, Kansas City, Denver. (Different routes from St. Louis to Kansas City.)
No. 8, *viâ* Pittsburg, Indianapolis, St. Louis, Kansas City, Pueblo, Denver.
No. 9, *viâ* Pittsburg, Indianapolis, St. Louis, Kansas City, Pueblo, Denver. (Different routes from Kansas City to Pueblo.)

Those intending to make observations of the eclipse, and desiring to take advantage of the courtesy extended by the Pennsylvanian Railroad Company, are requested to notify their intention by letter to the Superintendent of the U. S. Naval Observatory, asking that a letter, certifying to their identity be forwarded to their consuls at the port they may select for arrival in the United States. This letter must, upon delivery, be countersigned by the consul of the applicant to prevent mistakes.

The Hon. Secretary of the Treasury has notified the collector of customs of the ports of Boston, Portland, New York, Philadelphia, and Baltimore, of the probable arrival of European observers, who will be identified by exhibiting the above letter, so signed and countersigned, to the collectors named. Orders have been issued to them as follows:—

"Upon the arrival at your port of any of the gentlemen mentioned, you will extend all proper facilities for the speedy delivery to them of the professional instruments in question free of duty and charges."

On presenting the same letter, so countersigned, to the agent of the Pennsylvania Railroad Company in New York, Philadelphia, Baltimore, or Washington, a round-trip ticket to Denver and return, will be issued to them by the Railroad Company at the rates before named.

From Denver railroad lines extend to points likely to be chosen for observing stations.

NOTES

DR. WARREN DE LA RUE, F.R.S., has just made a second donation of 100*l*. to the Research Fund of the Chemical Society, stipulating that the whole sum be devoted to a single object.

MR. ROMANES being prevented, by domestic affliction, delivering his lecture at the Royal Institution, on Friday, the 5th inst., as announced, the Hon. Sec., Mr. W. Spottiswoode, Treasurer of the Royal Society, has undertaken to lecture in his stead, on "Quartz; an old Chapter Re-written."

PROF. A. AGASSIZ has returned from his cruise in the Gulf of Mexico, and in spite of bad weather and the grounding of the *Blake*, he has done fully as much as anticipated. As we have already stated, he made use of steel rope for dredging; the rope, however, was only $1\frac{1}{8}$ inch circumference, not $1\frac{1}{16}$ inch in diameter as we were led to believe. This steel rope came up fully to his expectations, and he is of opinion that hemp rope is not likely to be again used for deep-sea work by any one who has no time to spare. Prof. Agassiz is preparing a preliminary report to the Superintendent of the Coast Survey of his trip.

THE Iceland mail brings intelligence of a great eruption of Mount Hecla. On February 27, at 5 P.M., several smart shocks of earthquake were felt at Reykjavik, and in the same evening flames were visible behind the mountains, in the direction of Hecla. The Rev. Gudmund Jonsson, who lives close to Mount Hecla, states that at 4.30 P.M. of that day, slight shocks of earthquake began to be felt, these gradually increased till about 5 P.M., when two severe shocks occurred, creating a good deal of alarm, but doing no real damage. At 8 P.M. a tremendous eruption of flames appeared on the northern side of Hecla, the flames gradually increasing in size till they appeared like gigantic columns, double the height of the mountain. When the mail left Iceland on March 22, the eruption still continued, but apparently with diminished violence.

COPIOUS rains have fallen in the eastern districts of Cape Colony, and hopes are now entertained of the speedy termination of the disastrous drought referred to in NATURE, vol. xvii. p. 436. The heat in the east of the colony during January last is described as the most intense ever known in even that region of recurring scorching droughts.

THE correspondent of the *Scotsman* at Ottawa describes a curious phenomenon which occurred in the end of February at Niagara Falls. In the vicinity of Table Rock the river-bed was dry for hundreds of yards towards the centre of the Horse-shoe Falls, whilst the river below the falls was about twenty-four feet below high-water mark. For three days the appearance of the river both above and below the falls led to the idea that the falls would entirely cease for a time. This extraordinary circumstance was attributed to incessant high winds from N.E. and an ice-gorge at the rapids above damming the waters of the river till its bed was nearly dry. The icicles which hung from the rocks over which the falls are wont to pour, added to the remarkable character of the scene.

A NOTE sent by the Portuguese Government to the French papers states that a recent law has established in Mozambique and Angola a central council of agriculture, a station for conducting experiments, and a professorship of agriculture. In each capital public lectures will be given by the Government professor on zootechny and scientific agriculture.

THE educational authorities of Berlin possess an enormous garden in one of the suburbs of the city for the purpose of supplying all the schools with fresh botanical specimens. The distribution takes place regularly after April 1, and over 4,000,000 plants are required for botanical instruction during the course of the year.

PROF. OSSIAN-BONNET has been appointed to the Chair of Astronomical Physics in the Paris Faculty of Science and Letters.

A NUMBER of Algerian Arab chieftains have decided to visit the Paris Exhibition, and establish there a complete camp. They will bring with them a variety of Arab coursers.

SOME time since we called attention to the opening of a village museum at Castleton, Derbyshire. The mode of its arrangement has attracted a good deal of attention, and we are glad to hear that it is doing good work in the neighbourhood. A series of scientific lectures in connection with it has been very successful.

THE construction of the Tuileries captive balloon is attracting much attention in Paris. The necessary excavations for the rope-winding roller, the steam-engines, pulley, &c., &c., have modified the appearance of the old Tuileries yard. A large wooden saloon has been erected for the sewing of the canvas, which is quite ready; not less than 100 girls will be required for about a month. The work of making the rope, which is almost finished, has been immense. The weight of the netting will be 3,000 kilograms more than the displacement of the largest balloon in use. Besides the netting, the other ropes connecting the car, &c., will weigh 2,000 kilograms, and the large rope for mooring the balloon to the steam winding apparatus will be 3,000 kilograms. Experiments will be made to show that the rope can bear a traction of 50,000 kilograms, although it is not intended to ascend when the effort to move the balloon will exceed 12,000 kilograms. The real steam power required will be 300 horse-power. The displacement of the balloon will vary according to its station; on the ground it will be 24,430 cubic metres, but, floating at 600 metres in the air, it it will be 25,000.

SIR GEORGE AIRY sends to the *Times* of Saturday a paper giving an account of the public standards of length now mounted, by authority of the Corporation of the City of London, in the Guildhall, and of the care that has been taken to insure their accuracy. The standards consist of a line of 100 feet divided into tens of feet, and a line of 66 feet divided into tens of links, with some smaller divisions, on the floor of the Guildhall; and measures of three feet, two feet, and one foot, with subordinate divisions, on the north wall of the Guildhall. The lengths have been verified with the most scrupulous care by the officers of the Standards Department of the Board of Trade, and there is reason to believe that even the longest is not in error to the amount of one-hundredth of an inch. Sir George Airy has inspected these standards, and is satisfied with the general excellence of their construction.

THE meteor which was observed by Mr. Elliot at Hawick (p. 425) on March 25, at 10·20 A.M., was observed in various parts of Scotland, at Dunbar, Dundee, Cupar-Angus, and different parts of Fife. It is described as "apparently" several feet in circumference, cone-shaped, and at Dundee was observed to burst into a thousand fragments when near the earth.

M. KRANTZ, the Director-General of the Paris Exhibition, has been elected the president of a society for scientific excursions and demonstrations at the Champ de Mars. A circular has been issued by this organisation, which contains among its members a large number of influential scientific, industrial, and literary men. It is intended to organise a number of tours in the several sections under the guidance of experienced and competent teachers, the number of auditors admitted to each tour being limited to thirty. The charges will be very low, the society expecting to obtain for its professors and tourists a diminution of the entrance fee. Any communication may be sent to M. La Motte, editor, the secretary of the Association d'Excursions Scientifiques, Quai des Augustins, Paris. This society has been

sanctioned by the Ministry of Public Instruction, and these excursions are quite distinct from the lectures which will be organised on a large scale, as we mentioned a few weeks ago.

THE museum in the Paris Jardin des Plantes has ately been enriched by two very valuable collections. The first includes a vast variety of anthropological and ethnographical objects gathered by M. Pinart during his voyages in Polynesia, among which might be mentioned more especially the ancient stone statues from Easter Island, executed by a race unknown to the present inhabitants. The second consists of over 40,000 specimens in natural history, collected by M. Raffray in New Guinea, chiefly birds and insects.

M. SOLEIL, the well-known optician of Paris, who invented and patented the optical saccharimeter, patronised by Arago, has died at St. Gratian. He was eighty years of age, and had retired for the last twenty years.

ONE of the newly-opened streets in the Luxembourg Gardens, Paris, close to the Observatory, has been called "Rue Herschel," as a compliment to English astronomy.

IN the February session of the Deutsche anthropologische Gesellschaft, Prof. Bastian gave an interesting address on the occurrence of similar weapons among widely-separated African tribes, describing more particularly a peculiar kind of javelin, found by Schweinfurth on the eastern coast, by Pogge in the Gaboon region, and by other explorers in the Fan tribe of the interior. On the Gaboon coast it is preserved at present as a fetish, being no longer used. This, as well as other examples, tends to show the common origin of all the African races. The remains of an art closely allied to that of ancient Egypt even, have been discovered on the western coast by Dr. Pogge, who has brought back images, on which the beard and coiffure were the counterparts of those decorating the Egyptian statues 3,000 years ago.

IT has been stated by Mr. Rodwell (NATURE, vol. ix. p. 8), that the ancient Egyptians were acquainted with the principle of the "rider" in the balance. According to M. Wiedemann (*Annalen der Physik*) who has examined over 100 representations of Egyptian balances, this is based on a mistake. The Egyptian balance is a simple equal-armed one; a hook on the upper part of the stand supports a cord with terminal weight, or a plumb-line. In representation (perspective being unknown to the Egyptians), the hook and weight, as seen from the side, were drawn in the plane of the balance, so that the weight, in badly made figures, seems to hang, not from the hook, but from the balance-beam.

WE have received the Report of the Registrar-General of the province of Ontario for 1876. To the usual tables with the Report is added an interesting appendix by Mr. T. H. Monk, on the influence of the weather on the mortality of Toronto. The results show, so far as can be looked for, from one year's mortality numbering only 1,664 deaths, a general correspondence with those obtained by Mr. Buchan and Dr. Arthur Mitchell in their large inquiry into the influence of weather on the mortality of London. We hope Mr. Monk's suggestions will be carried out and that the inquiry will be extended so as to embrace the whole province, the health as well as the mortality of the people, and the registrations of the more prominent, if not of all the diseases, be printed for each week, in order to test more decisively the connection between weather and health and how far changes in the health and mortality of the people and the spread of epidemics may be foretold, as well as changes of weather, now so efficiently carried on in North America.

SINCE Mr. Darwin demonstrated processes similar to digestion in the plant organism, attention has been largely given to the discovery of substances of the nature of ferment in plants. M. van der Harst, of Utrecht, has lately examined the seeds of the garden bean (*Phaseolus vulgaris*) in this respect. He finds in these, when in germination, a ferment which can be extracted by means of glycerine. It has the power of transforming albuminous matter into peptones, and starch meal into glucose. It occurs exclusively in the seed lobes.

A CORRESPONDENT sends us the following extract from a letter of one of the officers of the ship *Newcastle*, of London. It is dated Brisbane, Sunday, 30th December, 1877. "Last Friday (28th) in the afternoon, it came over very black, so we expected a thunderstorm. Well, it came on to blow from the south, and then to hail. At first the hailstones were about the size of a marble, but they continued to increase, until they became as large and exactly the shape of a tomato. The captain weighed three and found that the three together weighed one pound. I was on the poop, under the awning, but the awning was blown adrift, which compelled me to beat a hasty retreat. Nearly all the glass in our large saloon ports on the starboard side is broken. To-day, when I was on shore, the houses in Queen Street, facing the south, looked as though there had been a great fire, not a pane of glass left, and in many cases the frames gone altogether. Of course, the backs of the houses on the other side of the street must have suffered to the same extent. During the squall, which lasted about three-quarters of an hour, the river was one mass of foam, caused by the hailstones raining upon its surface in such numbers."

AN interesting archæological discovery has been made at Cancello in the neighbourhood of Naples, by the uncovering of the cemetery of the ancient city of Luessula. The excavations made thus far have brought to light an immense number of interesting objects of ancient Greek civilisation. At Clermont-Ferrand, also, in Southern France, an old Roman villa has been laid bare and found to possess a rich treasure in the way of ornaments, &c.

AN interesting geological discovery has recently been made at Donaueschingen (Baden). A complete and very well-preserved skeleton of the prehistoric musk-deer (*Cervus elaphus muscosus*) has been found in the neighbourhood of this little town. The horns are of gigantic size and show over forty ends; it is aserted that this skeleton is the first complete one known.

M. LUIGI PONCI describes, in *L'Elettricista*, a new electric battery of great simplicity. It consists of the usual glass jar and porous cylinder; the latter, however, is filled with a solution of ferrous chloride (35° Beaumé), and has for a pole an iron plate, while the external solution is of ferric chloride (also 35° B.), and contains a carbon pole. The electro-motive power is 0·9 of that of a Daniel cell.

A ST. PETERSBURG correspondent, "C. S.," desiring to purchase a dictionary of chemistry, writes that he would gladly avail himself of a critical comparison of existing works of the kind. He suggests that a comparative estimate might be given through the pages of this journal. At the same time one of our Paris correspondents writes us on the appearance in Paris of the 25th number of the French "Dictionnaire de Chimie pure et appliquée," edited by Prof. Würtz; closing with the article on Vanadium. This important work was commenced by Prof. Würtz in 1869, assisted by a corps of twenty-five leading French chemists, and although delayed materially by the war and its results, has been pushed forward vigorously, until it is now on the eve of completion. It will form altogether five volumes, numbering nearly 5,000 pages, and will be the first record of chemistry approaching completeness in the French language. The chemist is still dependent in a great measure on the English language, for the seven bulky volumes of Watts's "Dictionary," including its two supplements, form the most extensive as well as most recent

compendium of chemical knowledge. Although Germany takes the lead in regard to chemical discovery, she is far behindhand in this respect. The new edition of the "Handwörterbuch," based on the well-known work of Liebig, Wöhler, and Kolber, now edited by Prof. Fehling, was commenced in 1871, but has progressed at a snail's pace, being only half way through the letter E, and the second of the six volumes which it will compose, not being yet completed. The Italian chemists have recently issued a dictionary of chemistry on a somewhat smaller scale than those alluded to above, but well edited and written.

THE additions to the Zoological Society's Gardens during the past week include two Pudua Deer (*Cervus humilis*) from Chili, a Black-faced Spider-Monkey (*Ateles ater*) from East Peru, deposited; an Arabian Gazelle (*Gazella arabica*) from Arabia, presented by Mr. W. W. Webb.

FOG SIGNALS[1]

DURING the long, laborious, and, I venture to think, memorable series of observations conducted under the auspices of the Elder Brethren of the Trinity House at the South Foreland in 1872 and 1873, it was proved that a short $5\frac{1}{2}$ inch howitzer, firing 3 lbs. of powder, yielded a louder report than a long 18-pounder firing the same charge. Here was a hint to be acted on by the Elder Brethren. The effectiveness of the sound depended on the shape of the gun, and as it could not be assumed that in the howitzer we had hit accidentally upon the best possible shape, arrangements were made with the War Office for the construction of a gun specially calculated to produce the loudest sound attainable from the combustion of 3 lbs. of powder. To prevent the unnecessary landward waste of the sound, the gun was furnished with a parabolic muzzle, intended to project the sound over the sea, where it was most needed. The construction of this gun was based on a searching series of experiments executed at Woolwich with small models, provided with muzzles of various kinds. The gun was constructed on the principle of the revolver, its various chambers being loaded and brought in rapid succession into the firing position. The performance of the gun proved the correctness of the principles on which its construction was based.

Coincident with these trials of guns at Woolwich gun-cotton was thought of as a possibly effective sound-producer. From the first, indeed, theoretic considerations caused me to fix my attention persistently on this substance; for the remarkable experiments of Mr. Abel, whereby its rapidity of combustion and violently explosive energy are demonstrated, seemed to single it out as a substance eminently calculated to fulfil the conditions necessary to the production of an intense wave of sound. What those conditions are we shall now more particularly inquire, calling to our aid a brief but very remarkable paper, published by Prof. Stokes in the *Philosophical Magazine* for 1868.

A sound wave consists essentially of two parts—a condensation and a rarefaction. Now air is a very mobile fluid, and if the shock imparted to it lack due promptness, the wave is not produced. Consider the case of a common clock pendulum, which oscillates to and fro, and which therefore might be expected to generate corresponding pulses in the air. When, for example, the bob moves to the right, the air to the right of it might be supposed to be condensed, while a partial vacuum might be supposed to follow the bob. As a matter of fact, we have nothing of this kind. The air particles in front of the bob retreat so rapidly, and those behind it close so rapidly in, that no sound-pulse is formed.

The more rapid the shock imparted to the air, the greater is the fractional part of the energy of the shock converted into wave motion. And as different kinds of gunpowder vary considerably in their rapidity of combustion, it may be expected that they will also vary as producers of sound. This theoretic inference is completely verified by experiment. In a series of preliminary trials conducted at Woolwich on the 4th of June, 1875, the sound-producing powers of four different kinds of powder were determined. In the order of their sizes they bear the names respectively of Fine-grain (F.G.), Large-grain (L.G.), Rifle Large-grain (R.L.G.), and Pebble-powder (P.). The charge in each case amounted to $4\frac{1}{2}$ lbs., four 24-pound howitzers being employed to fire the respective charges. There were eleven observers, all of whom, without a single dissentient, pronounced the sound of the fine-grain powder loudest of all. In the opinion of seven of the eleven the large-grain powder came next; seven also of the eleven placed the rifle large-grain third on the list; while they were again unanimous in pronouncing the pebble-powder the worst sound-producer. These differences are entirely due to differences in the rapidity of combustion.

These are some of the physical reasons why gun-cotton might be regarded as a promising fog-signal. Firing it as we have been taught to do by Mr. Abel, its explosion is more rapid than that of gunpowder. In its case the air-particles, alert as they are, will not, it may be presumed, be able to slip from places of condensation to places of rarefaction with a rapidity sufficient to forestall the formation of the wave.

As regards explosive material, and zealous and accomplished help in the use of it, the resources of Woolwich Arsenal have been freely placed at the disposal of the Elder Brethren. Gen. Campbell, Gen. Younghusband, Col. Fraser, Col. Maitland, and other officers, have taken an active personal part in the investigation, and in most cases have incurred the labour of reducing and reporting on the observations. Guns of various forms and sizes have been invoked for gunpowder, while gun-cotton has been fired in free air, and in the foci of parabolic reflectors.

On February 22, 1875, a number of small guns, cast specially for the purpose—some with plain, some with conical, and some with parabolic muzzles, firing 4 oz. of fine-grain powder, were pitted against 4 oz. of gun-cotton, detonated both in the open and in the focus of a parabolic reflector. The sound produced by the gun-cotton, reinforced by the reflector, was unanimously pronounced loudest of all. With equal unanimity, the gun-cotton detonated in free air was placed second in intensity. Though the same charge was used throughout, the guns differed considerably among themselves, but none of them came up to the gun-cotton either with or without the reflector. A second series, observed from a different distance on the same day, confirmed to the letter the foregoing result.

Meanwhile, the parabolic muzzle-gun, expressly intended for fog-signalling, was pushed rapidly forward, and on March 22 and 23, 1876, its power was tested at Shoeburyness. Pitted against it were a 16-pounder, a $5\frac{1}{2}$-inch howitzer, $1\frac{1}{2}$ lb. of gun-cotton detonated in the focus of a reflector, and $1\frac{1}{2}$ lb. of gun-cotton detonated in free air. On this occasion, nineteen different series of experiments were made, when the new experimental gun, firing a 3-lb. charge, demonstrated its superiority over all guns previously employed to fire the same charge. As regards the comparative merits of the gun-cotton fired in the open, and the gunpowder fired from the best constructed gun, the mean values of their sounds were found to be the same. Fired in the focus of the reflector, the gun-cotton clearly dominated over all the other sound-producers.[1]

The whole of the observations here referred to were embraced by an angle of about 70°, of which 50° lay on the one side and 20° on the other side of the line of fire. The shots were heard by eleven observers on board the *Galatea*, which took up positions varying from 2 miles to $13\frac{1}{2}$ miles from the firing-point. In all these observations, the reinforcing power of the reflector, and of the parabolic muzzle of the gun, came into play. But the reinforcement of the sound in one direction implies its withdrawal from some other direction, and accordingly we find that at a distance of $5\frac{1}{4}$ miles from the firing-point, and on a line, including nearly an angle of 90°, with the line of fire, the gun-cotton in the open beat the new gun; while behind the station, at distances of $8\frac{1}{2}$ miles and $13\frac{1}{2}$ miles respectively, the gun-cotton in the open beat both the gun and the gun-cotton in the reflector. This result is rendered more important by the fact that the sound reached the Mucking Light, a distance of $13\frac{1}{2}$ miles, against a light wind which was blowing at the time.

Theoretic considerations render it probable that the shape of the exploding mass would affect the constitution of the wave of sound. I did not think large rectangular slabs the most favourable shape, and accordingly proposed cutting a large slab into fragments of different sizes, and pitting them against each other. The differences between the sounds were by no means so great as the differences in the quantities of explosive material might lead one to expect. The mean values of eighteen series of

[1] "Recent Experiments on Fog Signals." Abstract of paper read at the Royal Society, March 21. By Dr. Tyndall, F.R.S., Professor of Natural Philosophy in the Royal Institution.

[1] In this case the reflector was fractured by the explosion.

observations made on board the *Galatea* at distances varying from $1\frac{3}{4}$ mile to 4·8 miles, were as follows:—

Weights	4-oz.	6-oz.	9-oz.	12-oz.
Value of sound ...	3·12	3·34	4·0	4·03

These charges were cut from a slab of dry gun-cotton about $1\frac{3}{4}$ inch thick; they were squares and rectangles of the following dimensions:—4 oz., 2 inches by 2 inches; 6 oz., 2 inches by 3 inches; 9 oz., 3 inches by 3 inches; 12 oz., 2 inches by 6 inches.

It is an obvious corollary from the foregoing experiments that on our "nesses" and promontories, where the land is clasped on both sides for a considerable distance by the sea,—where, therefore, the sound has to propagate itself rearward as well as forward—the use of the parabolic gun, or of the parabolic reflector might be a disadvantage rather than an advantage. Here gun-cotton, exploded in the open, forms the most appropriate source of sound. This remark is especially applicable to such light-ships as are intended to spread the sound all round them as from central foci. As a signal in rock lighthouses, where neither syren, steam-whistle, nor gun could be mounted, and as a handy fleet-signal, which dispenses with the lumber of special signal-guns, the gun-cotton will prove invaluable. But in most of these cases we have the drawback that local damage may be done by the explosion. The lantern of the rock-lighthouse might suffer from concussion near at hand, and though mechanical arrangements might be devised, both in the case of the lighthouse and of the ship, to place the firing-point of the gun-cotton at a safe distance, no such arrangement could compete, as regards simplicity and effectiveness, with the expedient of a *gun-cotton rocket*. Had such a means of signalling existed at the Bishop's Rock Lighthouse, the ill-fated *Schiller* might have been warned of her approach to danger ten, or it may be twenty, miles before she reached the rock which wrecked her. Had the fleet possessed such a signal, instead of the ubiquitous but ineffectual steam-whistle, the *Iron Duke* and *Vanguard* need never have come into collision.

It was the necessity of providing a suitable signal for rock lighthouses, and of clearing obstacles which cast an acoustic shadow, that suggested the idea of the gun-cotton rocket to Sir Richard Collinson, Deputy Master of the Trinity House. That idea was to place a disk or short cylinder of the gun-cotton, which had proved so effectual at low levels, in the head of a rocket, the ascensional force of which should be employed to carry the disk to an elevation of 1,000 feet or thereabouts, where by the ignition of a fuse associated with a detonator, the gun-cotton should be fired, sending its sound in all directions vertically and obliquely down upon earth and sea. The first attempt to realise this idea was made on July 18, 1876, at the firework manufactory of the Messrs. Brock, at Nunhead. Eight rockets were then fired, four being charged with 5 oz. and four with $7\frac{1}{2}$ oz. of gun-cotton. They ascended to a great height, and exploded with a very loud report in the air. On July 27, the rockets were tried at Shoeburyness. The most noteworthy result on this occasion was the hearing of the rockets at the Mouse Lighthouse, $8\frac{1}{2}$ miles E. by S., and at the Chapman Lighthouse, $8\frac{1}{2}$ miles W. by N.; that is to say, at opposite sides of the firing-point.

On December 13, 1876, and again on March 8, 1877, comparative experiments of firing at high and low elevations were executed. The gun-cotton near the ground consisted of $\frac{1}{4}$-lb. disks suspended from a horizontal iron bar about $4\frac{1}{2}$ feet above the ground. The rockets carried the same quantity of gun-cotton in their heads, and the height to which they attained, as determined by a theodolite, was from 800 to 900 feet. The day last-mentioned was cold, with occasional squalls of snow and hail, the direction of the sound being at right angles to that of the wind. Five series of observation were made on board the *Vestal* at distances varying from three to six miles. The mean value of the explosions in the air exceeded that of the explosions near the ground by a small but sensible quantity. At Windmill Hill, Gravesend, however, which was nearly to leeward, and $5\frac{1}{2}$ miles from the firing-point, in nineteen cases out of twenty-four the disk fired near the ground was loudest; while in the remaining five the rocket had the advantage.

Towards the close of the day the atmosphere became very serene. A few distant cumuli sailed near the horizon, but the zenith and a vast angular space all round it were absolutely free from cloud. From the deck of the *Galatea* a rocket was discharged, which reached a great elevation, and exploded with a loud report. Following this solid nucleus of sound was a continuous train of echoes, which retreated to a continually greater distance, dying gradually off into silence after seven seconds' duration. These echoes were of the same character as those so frequently noticed at the South Foreland in 1872-73, and called by me "aerial echoes."

On March 23, the experiments were resumed, the most noteworthy results of this day's observations being that the sounds were heard at Tillingham, 10 miles to the N.E.; at West Mersea, $15\frac{3}{4}$ miles to the N.E. by E.; at Brightlingsea, $17\frac{1}{2}$ miles to the N.E.; and at Clacton Wash, $20\frac{1}{2}$ miles to the N.E. by $\frac{1}{2}$ E. The wind was blowing at the time from the S.E. Some of these sounds were produced by rockets, some by a 24-lb. howitzer, and some by an 8-inch Maroon.

In December, 1876, Mr. Gardiner, the managing director of the Cotton-powder Company, had proposed a trial of this material against the gun-cotton. The density of the cotton, he urged, was only 1·03, while that of the powder was 1·70. A greater quantity of explosive material being thus compressed into the same volume, Mr. Gardiner thought that a greater sonorous effect must be produced by the powder. At the instance of Mr. Mackie, who had previously gone very thoroughly into the subject, a Committee of the Elder Brethren visited the cotton powder manufactory, on the banks of the Swale, near Faversham, on June 16, 1877. The weights of cotton powder employed were 2 oz., 8 oz., 1 lb., and 2 lbs., in the form of rockets and of signals fired a few feet above the ground. The experiments throughout were arranged and conducted by Mr. Mackie. Our desire on this occasion was to get as near to windward as possible, but the Swale and other obstacles limited our distance to $1\frac{1}{2}$ mile. We stood here E.S.E. from the firing-point while the wind blew fresh from the N.E. The cotton-powder yielded a very effective report. The rockets in general had a slight advantage over the same quantities of material fired near the ground. The loudness of the sound was by no means proportional to the quantity of the material exploded, 8 oz. yielding very nearly as loud a report as 1 lb. The "aerial echoes," which invariably followed the explosion of the rockets, were loud and long-continued.

On October 17, 1877, another series of experiments with howitzers and rockets was carried out at Shoeburyness. The charge of the howitzer was 3 lbs. of L.G. powder. The charges of the rockets were 12 oz., 8 oz., 4 oz., and 2 oz. of gun-cotton respectively. The gun and the four rockets constituted a series, and eight series were fired during the afternoon of the 17th. The observations were made from the *Vestal* and the *Galatea*, positions being assumed which permitted the sound to reach the observers with the wind, against the wind, and across the wind. The distance of the *Galatea* varied from three to seven miles, that of the *Vestal*, which was more restricted in her movements, being from two to three miles. Briefly summed up, the result is that the howitzer, firing a 3-lb. charge, which it will be remembered was our best gun at the South Foreland, was beaten by the 12-oz. rocket, by the 8-oz. rocket, and by the 4-oz. rocket. The 2-oz. rocket alone fell behind the howitzer.

On the following day, viz., October 18, we proceeded to Dungeness with the view of making a series of strict comparative experiments with gun-cotton and cotton-powder. Rockets containing 8 oz., 4 oz., and 2 oz. of gun-cotton had been prepared at the Royal Arsenal; while others, containing a similar quantity of cotton-powder, had been supplied by the Cotton-powder Company at Faversham. With these were compared the ordinary 18-pounder gun, which happened to be mounted at Dungeness, firing the usual charge of 3 lbs. of powder, and a syren.

From these experiments it appeared that the gun-cotton and cotton-powder were practically equal as producers of sound.

The effectiveness of small charges was illustrated in a very striking manner, only a single unit separating the numerical value of the 8-oz. rocket from that of the 2-oz. rocket. The former was recorded as 6·9 and the latter as 5·9, the value of the 4-oz. charge being intermediate between them. These results were recorded by a number of very practised observers on board the *Galatea*. They were completely borne out by the observations of the Coastguard, who marked the value of the 8-oz. rocket 6·1, and that of the 2-oz rocket 5·2. The 18-pounder gun fell far behind all the rockets, a result probably to be in part ascribed to the imperfection of the powder. The performance of the syren was, on the whole, less satisfactory than that of the rocket. The instrument was worked, not by steam of 70 lbs. pressure, as at the South Foreland, but by compressed air, beginning with 40 lbs. and ending with 30 lbs. pressure. The trumpet was pointed to windward, and in the

axis of the instrument the sound was about as effective as that of the 8-oz. rocket. But in a direction at right angles to the axis, and still more in the rear of this direction, the syren fell very sensibly behind even the 2-oz. rocket.

These are the principal comparative trials made between the gun-cotton rocket and other fog-signals; but they are not the only ones. On August 2, 1877, for example, experiments were made at Lundy Island with the following results. At two miles distant from the firing point, with land intervening, the 18-pounder, firing a 3 lb. charge, was quite unheard. Both the 4-oz. rocket and the 8-oz. rocket, however, reached an elevation which commanded the acoustic shadow, and yielded loud reports. When both were in view, the rockets were still superior to the gun. On August 6, at St. Ann's, the 4-oz. and 8-oz. rockets proved superior to the syren. On the Shambles Light-vessel, when a pressure of 13 lbs. was employed to sound the syren, the rockets proved greatly superior to that instrument. Proceeding along the sea-margin at Flamboro' Head, Mr. Edwards states that at a distance of 1¼ mile, with the 18-pounder gun hidden behind the cliffs, its report was quite unheard, while the 4-oz. rocket, rising to an elevation which brought it clearly into view, yielded a powerful sound in the face of an opposing wind.

On the evening of February 9, 1877, a remarkable series of experiments was made by Mr. Prentice, at Stowmarket, with the gun-cotton rocket. From the report with which he has kindly furnished me I extract the following particulars. The first column in the annexed statement contains the name of the place of observation, the second its distance from the firing-point, and the third the result observed :—

Stoke Hill, Ipswich ...	10 miles	Rockets clearly seen and sounds distinctly heard 53 seconds after the flash.
Melton	15 ,,	Signals distinctly heard. Thought at first that sounds were reverberated from the sea.
Framlingham	18 ,,	Signals very distinctly heard, both in the open air and in a closed room. Wind in favour of sound.
Stratford. St. Andrews..	19 ,,	Reports loud; startled pheasants in a cover close by.
Tuddenham. St. Martin	10 ,,	Reports very loud; rolled away like thunder.
Christ Church Park ...	11 ,,	Report arrived a little more than a minute after flash.
Nettlestead Hall	6 ,,	Distinct in every part of observer's house. Very loud in the open air.
Bildestone...	6 ,,	Explosion very loud, wind against sound.
Nacton	14 ,,	Reports quite distinct—mistaken by inhabitants for claps of thunder.
Aldboro	25 ,,	Rockets seen through a very hazy atmosphere; a rumbling detonation heard.
Capel Mills	11 ,,	Reports heard within and without the observer's house. Wind opposed to sound.
Lawford	15½ ,,	Reports distinct: attributed to distant thunder.

It is needless to dwell for a moment on the advantage of possessing a signal commanding ranges such as these.

The explosion of substances in the air, after having been carried to a considerable elevation by rockets, is a familiar performance. In 1873, moreover, the Board of Trade proposed a light-and-sound rocket as a signal of distress, which proposal was subsequently realised, but in a form too elaborate and expensive for practical use. The idea of the gun-cotton rocket with a view to signalling in fogs is, I believe, wholly due to the Deputy Master of the Trinity House.[1] Thanks to the skilful aid given by the authorities of Woolwich, by Mr. Prentice, and Mr. Brock, that idea is now an accomplished fact, a signal of great power, handiness, and economy, being thus placed at the service of our mariners. Not only may the rocket be applied in association with lighthouses and lightships, but in the Navy also it may be turned to important account. Soon after the loss of the *Vanguard* I ventured to urge upon an eminent naval officer the desirability of having an organised code of fog-signals for the fleet. He shook his head doubtingly, and referred to the difficult of finding room for signal-guns. The gun-cotton rocket completely surmounts this difficulty. It is manipulated with ease and rapidity, while its discharges may be so grouped and combined as to give a most important extension to the voice of the admiral in command.

I have referred more than once to the train of echoes which accompanied the explosion of gun cotton in free air, speaking of them as similar in all respects to those which were described for the first time in my report on fog-signals, addressed to the Corporation of Trinity House in 1874.[1] To these echoes I attached a fundamental significance. There was no visible reflecting surface from which they could come. On some days, with hardly a cloud in the air, and hardly a ripple on the sea, they reached us with magical intensity. As far as the sense of hearing could judge, they came from the body of air in front of the great trumpet which produced them. The trumpet-blasts were five seconds in duration, but long before the blast had ceased the echoes struck in, adding their strength to the primitive note of the trumpet. After the blast had ended the echoes continued, retreating further and further from the point of observation, and finally dying away at great distances. The echoes were perfectly continuous as long as the sea was clear of ships, "tapering" by imperceptible gradations to absolute silence. But when a ship happened to throw itself athwart the course of the sound, the echo from the broadside of the vessel was returned as a shock which rudely interrupted the continuity of the dying atmospheric music.

The day on which our latest observations were made was particularly fine. Before reaching Dungeness the smoothness of the sea and the serenity of the air caused me to test the echoing power of the atmosphere. A single ship lay about half a mile distant between us and the land. The result of the proposed experiment was clearly foreseen. It was this. The rocket being sent up, it exploded at a great height; the echoes retreated in their usual fashion, becoming less and less intense as the distance of the surfaces of reflection from the observers increased. About five seconds after the explosion, a single loud shock was sent back to us from the side of the vessel lying between us and the land. Obliterated for a moment by this more intense echo, the aërial reverberation continued its retreat, dying away into silence in two or three seconds afterwards.

I have referred to the firing of an 8-oz. rocket from the deck of the *Galatea*, on March 8, 1877, stating the duration of its echoes to be seven seconds. Mr. Prentice, who was present at the time, assured me that, in his experiments with rockets, similar echoes had been frequently heard of more than twice this duration. The ranges of his sounds alone would render this result in the highest degree probable.

There is not a feature connected with the aërial echoes which cannot be brought out by experiments in the laboratory. I have recently made the following experiment:—A rectangle 22 inches by 12, is crossed by twenty-three brass tubes, each having a slit along it from which gas can issue. In this way, twenty-three low, flat flames are obtained. A sounding reed, fixed in a short tube, is placed at one end of the rectangle, and a "sensitive flame" at some distance beyond the other end. When the reed sounds, the flame in front of it is violently agitated, and roars boisterously. Turning on the gas, and lighting it as it issues from the slits, the air above the flames becomes so heterogeneous that the sensitive flame is instantly stilled by the aërial reflection, rising from a height of 6 inches to a height of 18 inches. Here we have the acoustic opacity of the air in front of the South Foreland strikingly imitated. Turning off the gas, and removing the sensitive flame to some distance behind the reed, it burns there tranquilly, though the reed may be sounding. Again lighting the gas as it issues from the brass tubes, the sound reflected from the heterogeneous air throws the sensitive flame into violent agitation. Here we have imitated the aërial echoes heard when standing behind the syren-trumpets at South Foreland. The experiment is extremely simple and in the highest degree impresssive.

THE IRON AND STEEL INSTITUTE

THE ninth annual meeting of the members of the Iron and Steel Institute was commenced on Thursday in the rooms of the Institution of Civil Engineers in Westminster. The chair was occupied by Dr. C. W. Siemens, F.R.S., the President of the Institute, and the proceedings were commenced by the reading of the Annual Report of the Council, which stated that the total number of members now exceeds 900, while a steady accession of new members continues, there being 47 proposed for election at the present meeting. The Council referred to the increase of foreign members, which shows the interest taken in the institute by Continental and American metallurgists. An invitation received from M. Tresca on behalf of the Société des Ingénieurs Civils, to visit Paris in the ensuing summer and the concurrent holding of the International Exhibition in that city,

[1] I have proposed that it should be called the "Collinson Rocket."

[1] See also *Philosophical Transactions* for 1874, . 183.

have induced the Council to recommend that the next autumn meeting should be held in Paris. A sum of 2,318*l*. has been raised by the Institute for the widow and family of Mr. Jones, the late general secretary.

The President stated that the Bessemer medal had been awarded to Prof. Tunner, of Leoben, Austria, in consequence of the great distinction that gentleman had earned for himself in his researches in that branch of science which the Institute so specially represented.

One of the most important papers read was by Mr. I. Lowthian Bell, M.P., F.R.S., on the separation of phosphorus from pig iron. In this paper Mr. Bell detailed his further experiences in his endeavours to eliminate the phosphorus from the iron, its presence having a weakening effect on the metal. Fully five-sixths of the pig iron manufactured in Great Britain is made from ores which, when smelted, give a product containing from three-tenths of a unit to nearly 2 per cent. of phosphorus. When, however, this element exists in pig iron to the extent of much more than one-tenth of a unit per cent. it is unfit for the Bessemer converter—at all events when ordinary spiegel iron, containing 10 or 12 per cent. of manganese, is used for its final purification. Bessemer steel rail-makers are, therefore, obliged to reject iron which formerly sufficed for the manufacture of iron rails, an iron comparatively free from phosphorus being necessary. That, therefore, affected the prosperity of the mines which formerly supplied the rail makers with ore, as well as the blast furnaces which produced the pig iron from that ore. Mr. Bell explained that at the high temperature of the Bessemer converter, while the carbon was removed by the air during its passage through the metal, the phosphorus was not affected. This he stated was also the case to a certain extent in the ordinary refinery furnaces; with a more moderate temperature, however, the conditions which bound carbon and phosphorus with iron were materially changed. The iron was more or less oxidised, and the oxide of iron so formed acted on the carbon and phosphorus. When the phosphorus is removed its loss is accompanied by a separation of the carbon contained in the pig iron. Loss of carbon, however, deprives the metal of its susceptibility of fusion at the temperatures at which the operation of refining and puddling are carried on, and when once the metal is solid the further elimination of phosphorus is very difficult, if not impossible. Mr. Bell expressed the opinion that a lower temperature probably weakened the affinity of phosphorus for iron, as they existed in the crude metal, or strengthened the affinity between oxide of iron and phosphoric acid. A third condition involved in the mere condition of heat might be a diminution of the power possessed by oxide of iron in attacking the carbon, that element which enabled the crude metal to maintain fluidity when moderately heated. The author said that whichever one or more than one of the three conditions was required, the fact remained that melted crude iron might be maintained in contact with melted oxide of iron, and still retain carbon enough to prevent it solidifying, while the phosphorus rapidly disappeared. Instances were given of 95 per cent. of phosphorus being removed, while only 10 per cent of the carbon had been dissipated. The process consists in the more rapid agitation of the two substances while in a liquid condition. The iron so heated may be puddled for the production of malleable iron, or used for the manufacture of steel. Specimens of steel of the highest quality which had been so produced at the Royal Arsenal, Woolwich, were exhibited.

Dr. Percy, F.R.S., gave some particulars as to the manufacture of Japanese copper. Bars of this metal present a beautiful rose-coloured tint on their surface, which is due to an extremely thin and pertinaciously adherent film of red oxide of copper or cuprous oxide. This tint is not in the least degree affected by free exposure to the atmosphere. Dr. Percy placed before the meeting bars which he had possessed for thirty years, and which had undergone no change, although freely exposed to the atmosphere. The secret of this result lies in casting the copper under water, the metal being very highly heated and the water being also made hot. Dr. Percy stated that he had succeeded in casting copper in this way, and had produced similar results to those shown in the Japanese metal.

Other papers read were:—"On some Recent Improvements in the Manufacture of Iron Sponge by the Blair Process," by Mr. J. Ireland; "Statistics on the Production and Depreciation of Rails," by Mr. Charles Wood; "On Steel-casting Apparatus," by Mr. Michael Scott; "On Railway Joints," by Mr. C. H. Halcomb; and "On the Manufacture of Bessemer Steel and Steel Rails," by Mr. C. B. Holland.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Council of the Senate recommend that the application of Prof. C. C. Babington for skilled assistance at the Botanical Museum be granted, and that an assistant curator of the Herbarium be appointed at a salary of 100*l*. per annum, the appointment to be made by the Professor with the consent of the Vice-Chancellor, and to be for a period of four years. It is in contemplation to appoint a non-collegiate student.

BALTIMORE.—The Anniversary of the Johns Hopkins University was celebrated on February 22, when addresses were given by some of the professors and others. So far the progress of the University has been thoroughly satisfactory. One of its principal aims is to encourage original research, both among professors and students, and fellowships are granted to those who show aptitude for such work. Prof. Remsen, in his address, showed that a lofty idea of what original research really is, is entertained at the University; it is not merely the establishing of an isolated fact, the devising of a new piece of apparatus, the simple analysis of a new mineral, the discovery of an extra tooth in some abnormal animal; it is, rather, a systematic attempt to solve a definite problem, involving the use of a variety of methods peculiar to the special branch in which the attempt is made. In the three laboratories, biological, physical, and chemical, a variety of important work is being carried on, and altogether, both in the kind and amount of work which is being done under the auspices of the university, the trustees and professors show that they have a thorough appreciation of the spirit of the founder's legacy.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, March 14.—Lord Rayleigh, F.R.S., president, in the chair.—Mr. Artemas Martin, Erie, Pa., was proposed for election.—The Secretary communicated a paper by Prof. J. Clerk Maxwell, on the electrical capacity of a long narrow cylinder and of a disc of sensible thickness. Prof. Cayley, Mr. J. W. L. Glaisher, Mr. Roberts, and the President made short communications.

Royal Astronomical Society, March 8.—Lord Lindsay, president, in the chair.—Mr. Neison read a paper on Hansen's terms of long period in the lunar theory. Mr. Proctor drew some diagrams referring to the position of the axis of Mars, and spoke upon Mr. Stone's paper of last January. Mr. Neison made some illustrative remarks thereon.—A paper by Mr Plummer was read on the supposed influence of a mass of brick-work upon the errors of a transit instrument in its neighbourhood. Several Fellows commented upon this paper and described the lively behaviour of their transit-piers; Mr. Dunkin said there was nothing new about it.—A paper by Mr. Stone was read on telescopic observations of the Transit of Venus. Mr. Gill spoke on the difficulties concerning contacts, and some discussion followed.—A paper was announced by Prof. Sedley Taylor on Galileo's trial before the Inquisition in the light of recent researches; likewise an atlas of the ecliptic, by Heiss, of stars down to the fifth magnitude on Mercator's projection, made in order to get people to lay down the zodiacal light.—There were several other papers.

Entomological Society, March 6.—H. W. Bates, F.L.S., F.Z.S., president, in the chair.—Mr. John Woodgate was elected a Member of the Society.—Mr. F. Moore, at the request of Sir W. H. Gregory, late governor of Ceylon, exhibited a large series of drawings, executed by native artists, of the transformations of the lepidoptera of the island. These drawings were made under the direction of Dr. Thwaites, and represented, for the first time, the life-history of many species.—Mr. McLachlan exhibited some entomological parts of the great Russian work "Fedtschenkos' Travels in Turkestan."—Mr. H. Goss exhibited a small collection of fossil insects obtained by Mr. Gardner from the Bournemouth leaf beds (middle eocene). The collection comprised numerous elytra of coleoptera, and wings of neuroptera, &c.—Mr. J. Mansel Weale read some notes on South African insects. These referred to variation in *Pieris severina* and *Pieris mesentina*; to the secretion of formic acid in *Termes trinivervius*, and the probable localisation of the same in a cephalic process, and also to the larvæ of some Hesperidæ in relation to the subject of protective resemblance.—Mr. Ed. Saunders read a paper entitled "Remarks on the Hairs of some of our British Hymen-

optera." From a microscopical examination the author found that the presence of branched or plumose hairs is characteristic of the Anthophila, whilst the hairs of the Fossores, of Heterogyna, and of the Diploptera, are all simple, or in some cases twisted.—Mr. A. G. Butler communicated a paper on the natural affinities of the lepidopterous family Ægeriidæ. From an examination of structural characters, Mr. Butler considered that these insects presented no resemblance to the Sphingidæ, with which they had hitherto been allied, but were more related to the Pyrales and the Gelechiidæ. The president, in favour of this view, remarked that the whole of the Ægeriidæ had been made to depart from their congeners in appearance, through the action of mimicry.—The Secretary read a paper, by Mr. A. H. Swinton, on the biology of insecta, as determined by the emotions. The paper dealt chiefly with cases of simple muscular contractions and secretions.—Mr. Peter Cameron communicated a paper on some new genera and species of Tenthredinidæ.

Zoological Society, March 5.—Prof. Newton, F.R.S., vice-president, in the chair.—Mr. Sclater exhibited and made remarks on a second collection of birds from Duke of York Island, New Britain and New Ireland, which he had received from the Rev. George Brown, C.M.Z.S.—Mr. Sclater exhibited and made remarks upon a specimen of *Athene variegatæ*, and upon the type-specimen of *Fulica gallinuloides* of King, belonging to the Museum of Science and Art, Edinburgh.—Prof. Newton, F.R.S., drew attention to the statement of Legaut that every Solitaire (*Pezophaps solitaria*) carried a stone in its gizzard, and exhibited one of three stones found by Mr. Caldwell, C.M.Z.S., associated with the remains of as many birds of that species in the caves of Rodriguez.—Mr. T. J. Parker described the stridulating apparatus of *Palinurus vulgaris*, which consisted in a peculiar modification of the second joint of the antennæ working against the lateral surface of the antennulary sternum.—A communication was read from Mr. C. Spence Bate, C.M.Z.S., containing an account of the crustaceans of the Coast of Coromandel, collected by Sir Walter Elliot, K.C.S.I.—Mr. A. Boucard, C.M.Z.S., read notes on some coleoptera of the genus *Plusiotis*, and gave descriptions of three new species from Mexico and Central America.—A communication was read from Mr. Arthur G. Butler, F.Z.S., containing an account of a small collection of lepidoptera, obtained by the Rev. J. S. Whitmee, at the Ellice Islands.—A communication was read from Mr. Edward J. Miers, F.Z.S., on the *Penæidæ* in the collection of the British Museum.—Mr. George French Angas read the description of a new genus of land shells belonging to the family *Cyclophoridæ*, for which he proposed the name of *Mascaria*.—Mr. Angas also read descriptions of nine new species of land and marine shells from various localities, amongst which was a new *Rostellaria*, proposed to be named *R. luteostoma*, and a new *Bulimus* from Madagascar, proposed to be called *B. watersi*.—A communication was read from Dr. G. E. Dobson, C.M.Z.S., containing additional notes on the chiroptera of Duke of York Island and the adjacent parts of New Ireland and New Britain.—A communication was read from Mr. Robert Collett, C.M.Z.S., containing an account of *Latrunculus* and *Crystallogobius*, two remarkable forms of gobioid fishes found in Scandinavia.

Institution of Civil Engineers, March 26.—Mr. Bateman, president, in the chair.—The paper read was on direct acting or non-rotative pumping engines and pumps, by Mr. Henry Davey, Assoc. Inst. C.E.

PARIS

Academy of Sciences, March 25.—M. Fizeau in the chair.—The following papers were read:—Experiments designed to imitate various forms of foldings, distortions, and ruptures presented by stratified rocks, by M. Daubrée. He used an apparatus in which vertical and horizontal pressure could be produced, with screws, on sheets of metal of various thickness (especially lead), also sheets of wax mixed with plaster, resin, turpentine, &c. Various effects of a geological character were obtained.—Craniology: the Tasmanian race, by MM. de Quatrefages and Hamy. This relates to the sixth volume of the author's "Crania Ethnica." The Tasmanians formed a race by themselves, and remarkably homogeneous. Their cranial capacity is considerably over that of the Nubian negroes, yet the latter are socially much above the former. On the whole, the Tasmanian cranium does not present marked signs of inferiority. M. Hamy's measurements were made on at least fifty-four osseous heads and six skeletons.—On the treatment of wounds by occlusion, by M. Ravaisson-Mollien. In the winter of 1869, suffering greatly from chapped hands, he filled the wounds with filaments of wadding and then covered them with collodion. This gave relief and speedy cure. He communicated the fact to M. Nelaton, who, with M. Guerin, was then studying the treatment of wounds with occlusion of air.—Observations on the nature of the plants united in the group of *Nœgerrathia*; generalities and type of *Nœgerrathia foliosa*, Sternb., by M. De Saporta.—On the origin of the Phylloxera discovered at Bades (Eastern Pyrenees), by M. Planchon. This outbreak is shown to be due to introduction of some 500 vine-stocks from Gard, in France, five years ago. It is a mistake to regard the American vines as alone pestiferous. M. Duval Jouve was elected correspondent for the Section of Botany, in room of the late M. Hofmeister.—On a map of the erratic blocks of the valley of the Arboust, ancient glacier of Oo (environs of Lachon, Haute Garonne), by MM. Trutat and Gourdon.—M. Dumas presented fascicle A of Measurements of the photographic negatives of the Transit of Venus.—M. Lecoq de Boisbaudran stated that he had prepared several anhydrous chlorides, bromides, and iodides of gallium. The atomic weight of gallium (according to two experiments) was 69.9.—Results of observations in 1877 on the sun's limb on the lines *b* and 1474 *k*, by M. Tacchini. The mean number of positions daily of these lines shows a minimum in agreement with that of the sun-spots. From maximum to minimum the diminution of visibility of *b* is greater than for 1474 *k*. Iron has an enormous preponderance at the base of the chromosphere; magnesium comes next. The other substances are of comparatively slight frequency, and they nearly disappear at the minimum of spots.—New considerations on the observation and reduction of lunar distances at sea, by MM. Beuf and Perrin.—On the effects of the rheostatic machine, by M. Planté. *Inter alia*, the difference in character of the electricity from the positive pole and that from the negative is more marked than with the electric machine or induction coil. (The forms of the sparks are described.)—On a *camera lucida*, by M. Pellerin. This describes an arrangement (copying M. Cornu's polariser) which gives two images of the same intensity visible at the same time by the whole pupil.—On a hydrate of ether, by M. Tanret. In filtering an etherised solution in free air, a crystallisation occurs at the upper part of the filter. This, got otherwise in larger quantity, was what the author examined, and found a true combination of ether and water of the nature of cryo-hydrates.—On the constitution of wool and some similar products, by M. Schutzenberger. Wool gives a fixed residue presenting the same elementary and immediate composition as that of albumen; the proportions of ammonia, carbonic acid, and oxalic acid are considerably higher than with albumen; acetic acid and pyrrol are in similar proportions.—On the formation of partitions in the stylospores of Hendersonias and Pestalozzias, by M. Crié.—On some new facts of perlitism of rocks, and on the artificial reproduction of perlitic fissures, by MM. Fouqué and Lévy. This reproduction is by treating hydrofluosilicic acid with excess of carbonate of lime, filtering the mixture (slightly diluted with water), receiving a drop of the liquid which passes on a piece of glass covered with Canada balsam, and letting dry.—On the period of rotation of solar spots, by Mr. Brown.—M. Gaiffe presented an apparatus which enables one to determine immediately, by a simple reading, the electromotive force of any electric generator.

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